SCIENCE ABSTRACTS.

Section A.—PHYSICS.

DECEMBER 1925.

GENERAL PHYSICS.

2639. *Quantum Relations in Series Spectra.* **R. B. Lindsay.** (Optical Soc. America, J. and Rev. Sci. Inst. 11. pp. 17–30, July, 1925.)—In two parts. In the first is presented a calculation of the orbits and effective quantum numbers in stripped atoms of the third periodic group. By assuming as a first approximation that the orbits are Kepler ellipses, values of E and r are obtained which are substituted back into the quantum condition: $\oint\sqrt{2m\mathrm{E} - 2m\mathrm{V} - \frac{k^2h^2}{4\pi^2r^2}}\cdot dr = (n-k)h$, which can then be evaluated, using the usual screening assumption. Hence a value of $(n-k)$ is derived, and a further approximation can be made. Two approximations are found to be sufficient. A table of V as a function of r for the elements Na to Cl^{6+} is given, and a comparison of the effective quantum numbers derived from this with those experimentally determined. The agreement is exact. Tables are also given of the aphelial distances of the orbits 1_1, 2_2 and 2_1 for these atoms as well as values for the 3_1 orbit of the integral $\int p_r dr$ for the part within the aphelion of the 2_1 orbit and the part without. There is also given the value of the integral for the whole of the Kepler ellipse, which coincides with the outer part of the true orbit and which is associated with the same energy. The second part is concerned with the ratio of quantum defects in successive stripped atoms in the same group. It is seen that the ratio is expressed by $q/q' = 1 + f$, where f is a fraction in the neighbourhood of 0·2, but decreasing slightly with the atomic numbers. By writing the radial quantum term in two parts, due to the portions of the orbit inside and outside the shell enclosing all inner orbits and applying rough approximations to these terms, it is first shown that the ratio of the quantum defects is of the order observed. A closer approximation is then made. The quantity q can be written in the form $(\mathrm{I}_i - \mathrm{I}_{ei}) + (\mathrm{I}_o - \mathrm{I}_{eo})$, where $\mathrm{I} = \frac{1}{h}\int p_r dr$ and the subscript i refers to inside, o to outside and e to equivalent ellipse. By further approximation it is possible to get I_{ei} in terms of b, the radius of the shell and the eccentricity of the equivalent ellipse. It is found that b can be well represented by a form $(\mathrm{A}/(\mathrm{N} - \mathrm{B})$, and hence the inner contribution to the quantum defect is in the form

$(A + BN)/(N - C)$, and it is shown that the outer contribution is of the same form. Hence finally for the ratio of the quantum defects is obtained $q/q' = 1 + 1/(N - 6{\cdot}70)$, which agrees well in the case of the stripped atoms of the third group, but which breaks down, as would be expected from the method of derivation, for non-penetrating orbits. It is hoped that this quantum defect ratio will prove useful in fixing series terms in higher order spectra. A. Wh.

2640. *Thermal Equilibrium between Quantum-Atoms and Vacuum-Radiation.* **P. Jordan.** (Zeits. f. Physik, 33. 9. pp. 649–655, 1925.)—The known Einstein law of probability for the interaction of radiation and matter calls for an amendment when for the material atom the new statistic of Bose and Einstein is adopted. The author suggests a simple and natural amendment which brings the thermal equilibrium into the required form. **Einstein** approves. A. D.

2641. *The Relation of the Restricted to the General Theory of Relativity and the Significance of the Michelson-Morley Experiment.* **W. F. G. Swann.** (Science, 62. pp. 145–148, Aug. 14, 1925.)—The notion of the existence of the velocity c of the restricted theory of relativity is deduced as a consequence of the departure of planetary motion from Newtonian mechanics. Further, it is possible to choose systems of coordinates for the expression of the laws of physics, such that these systems differ slightly from those in which the laws should be expressed for their exact truth, whilst the difference is so small as to escape detection except when, as in the Michelson-Morley experiment, the test can be made with sufficient precision. [See Abstract 2229 (1925).] J. S. G. T.

2642. *Certain Quantum Theory Postulates.* **D. N. Mallik.** (Phil. Mag. 50. pp. 381–389, Aug., 1925.)—From Lagrange's equations in generalised coordinates, if T, V are the kinetic and potential energies and p's the generalised principal coordinates, $\Sigma(d\partial T/dt\partial\dot{p} - \partial T/\partial p + \partial V/\partial p)dp = 0$. Multiplying by dt and integrating, provided we can admit that the order of integration is indifferent, we have $\int\Sigma\partial T/\partial\dot{p}\,.\,dp + \int\Sigma\partial(T - V)/d\dot{p})dp/dt =$ constant. This yields equations of the type $\int\partial T/d\dot{p}\,.\,dp =$ constant, since p's are independent, admitting $\Sigma\int\partial/\partial p\,.\,(T - V)dpdt = \delta\int(T - V)dt = 0$. This, the author states, seems reasonable, since the initial and final configurations being prescribed, there is nothing to distinguish, during the integration, between the present operator ∂ and the operator δ of the calculus of variations. In any case, the left-hand side is zero for a closed orbit. Now in accordance with quantum ideas, we may evidently take, subject to the above-mentioned limitations, $\int\partial T/\partial\dot{p}\,.\,dp = n_p h$ . . . (5), where n_p is an integer and h is Planck's constant, showing the exact relation between classical and quantum dynamics. Again, if E is the total energy of the system, $2\int E dt = \int\Sigma(\partial T/\partial\dot{p}\,.\,\dot{p} + \int\partial V/dp\,.\,dp)dt = \int\Sigma\partial T/\partial\dot{p}\,.\,dp + \int\Sigma F_p dp = \Sigma\int\partial T/\partial\dot{p}\,.\,dp$ . . . (6), if $\Sigma\int F_p dp = 0$, F_p being the impulse corresponding to p. This, of course, would be true whenever the displacement is zero while the impulse lasts. Assuming this as a condition in the postulation of quantum theory, we get $\int E dt = Nh$ from (5) and (6), where N is an integer, since fractional values of the coefficient of h are excluded. Taking this as the fundamental postulate of the quantum theory, Fermat's law of swiftest propagation of light and Planck's postulate regarding the equality between the frequency in a stationary orbit and that of subsequent radiation are deduced. It is then shown that this equality and also the Zeeman and Stark effects may be explained by considering the motion as that in a disturbed circular orbit. This suggests a concordance between the quantum theory and the ordinary wave theory view-points. It is then pointed out that both theories fix attention on the mean value of the energy of radiation, which can also be shown, on the ordinary electron theory, to be proportional, in some cases at least, to the frequency postulated in the quantum theory. G. W. DE T.

2643. *Remarks on Two-coupled Multiply-Periodic Systems, the Statistics of Quantum Theory and the Theory of Dispersion.* **G. Breit.** (Washington Acad. Sci., J. 15. pp. 269–278, July 19, 1925.)—The interactions between quantised systems is discussed mathematically with reference to the scattering of light and optical dispersion. The results in general agree with those found by Kramers and Heisenberg [see Abstract 1632 (1925)], but are of somewhat more general application [see Abstract 1071 (1925)]. J. S. G. T.

METEOROLOGY AND GEO-PHYSICS.

2644. *Clouds and Forecasting Weather.* **E. van Everdingen.** (Roy. Meteorolog. Soc., J. 51. pp. 191–203, July, 1925.)—The author discusses the value of cloud study in relation to weather-lore and to scientific forecasting. Types of cloud associated with certain meteorological conditions are shown, and it is pointed out that valuable information concerning the vertical temperature distribution over large areas may be obtained from a knowledge of the cloud forms in the lowest 5 km. Conditions for the periods October 28–29, 1922, and April 2–4, 1925, are detailed in order to show the utility to the forecaster of observations of the motion of cirrus. A. W. L.

2645. *Geophysics.* **H. Lamb.** (Engineering, 120. pp. 267–269, Aug. 28, 1925. Nature, 116. pp. 333–339, Aug. 29, 1925. Supplement Science, 62. pp. 229–236, Sept. 11, 1925. Paper read before the British Assoc., Southampton, Aug., 1925.)—This paper contains no new results, but affords an interesting summary of recent work in all branches of geophysics. W. A. R.

ASTRO-PHYSICS.

2646. *Determination of Proper Motions of Stars from 5th to 16th Magnitude, photographed on First Plates taken by Brothers Henry.* **V. Nechvile.** (Comptes Rendus, 181. pp. 210–212, Aug. 3, 1925.)—Twenty-two Henry plates, obtained earlier than the astrographic chart, have been examined in the Blink microscope. The investigations are made over 118°·8 (square) of the sky, and divided into four groups appertaining to the zones for Uccle-Potsdam, Helsingfors, Vatican, and Greenwich, affording 3802 stars. A maximum is found for motions of 0″·02 – 0″·03 per annum, indicating that all motions up to this limit have been measured. The Blink microscope lends itself particularly to the examinations of double stars, and four new doubles are given, of which one is τ Cygni (mag. 5·3), hitherto counted single and figuring among the fundamental stars of the *Connaissance des Temps*; its companion is of mag. 13·7 at a distance of 93″·64. The hypothetic parallax for this double is 0″·188. Another is a faint binary of the 61 Cygni type. Two stars (BD + 56 1718 and 1719), which are relatively far apart, have parallel motions of the same order. A. S. D. M.

2647. *Spectral Classification of Faint Milky Way Stars in Aquila.* **C. Schalén.** (Ark. f. Mat. Astron. och Fysik, Stockholm, 18. No. 36. pp. 1–9, 1925. In English.)—A field near Altair is partly rich, partly poor in stars, and it is assumed that the poor region forms the foreground, and that a dark nebula hides the background of the galactic star cloud. The author subtracts the numbers of stars in the poor region from the corresponding numbers of the different spectral types in the rich region, so finding the real distribution of types in the Milky Way cloud. He applies Kapteyn's formulæ in Raab's form, and from the A-type stars deduces the distance of the cloud as 965 parsecs [see next Abstract]. A. S. D. M.

2648. *Effective Wave-lengths of Faint Milky Way Stars.* **J. H. Petersson.** (Ark. f. Mat. Astron. och Fysik, Stockholm, 19a. No. 3. pp. 1–21, 1925. In English.)—A study of the effective wave-lengths of a galactic region near Altair [see preceding Abstract]. The author describes the nature of the region, his methods of measuring and reducing the observations, and discusses the distribution of the stars as regards λ· eff. and apparent magnitude, assuming that the star-rich region continues into the star-poor region, but is concealed by dark nebulous matter. He eliminates the nearer stars by subtracting the star-poor numbers from the corresponding star-rich numbers in magnitude and colour, and finds that the star-rich region contains a predominance of A-type stars, and has relatively few red stars. He uses Kapteyn's formulæ in Raab's form, and by means of the A-type stars finds the distance of the star-rich region as 1500 parsecs. He compares this with the distances of the Hyades, Præsepe, and Messier II. A. S. D. M.

2649. *Two Stellar Spectra of the P Cygni Type.* **P. W. Merrill.** (Mt. Wilson Observat. Contrib. No. 295. Astrophys. J. 61 pp. 418–423, June, 1925.)

2650. *The Theory of the Stellar Absorption Coefficient.* **S. Rosseland.** (Mt. Wilson Observat. Contrib. No. 296. Astrophys. J. 61. pp. 424–442, June, 1925.)—A reliable theory of the absorption coefficient of strongly ionised matter is a necessary complement to any theory of the internal constitution of stars. In the present paper such a theory is developed deliberately as a generalisation from X-ray absorption experiments only, and partly checked by experiments of Anderson and Harrison. On the basis of this theory the expression of the flux of radiant energy in a star is calculated and the result compared with Eddington's theory of a star in radiative equilibrium. AUTHOR.

2651. *Refraction Effects on Stellar Plates due to Long Exposures.* **W. M. Smart.** (Roy. Astron. Soc., M.N. 85. pp. 682–692, June, 1925.)—During a long exposure of a stellar plate the rate of variation of the refraction due to zenith distance is not constant over the whole plate. Hence if the plate is correctly guided for a star at its centre, the images of the stars at other parts will be subject to a form of distortion. In this paper the geometry of the effect is discussed and numerical estimates made for a region in declination 0° for a latitude 45°. A diagram is given showing the shift corresponding to hour-angles 0^h, 1^h, 2^h, 3^h, and 4^h. It is shown that the magnitude increases very rapidly for the greater values of hour-angle. It is concluded that in the investigation of proper motions an error of $2''$ per century might be made if the plates were exposed from 23^h to 1^h and from 1^h to 3^h with an interval of ten years. A. Wh.

2652. *Henry Draper Extension.* **Annie J. Cannon.** (Harvard Coll. Obs., Annals, 100. No. 1. [16 pp.], 1925.)—Four thousand spectra have been obtained and classified on a plate (centre at $20^h + 37°$), covering 83 square degrees, taken with the 10-in. Metcalf telescope at Arequipa on September 7, 1923. The photographic magnitudes are based on the International Scale; the star positions (reduced to 1900) are taken from the Bonn Durchmusterung, the Potsdam Astrographic Catalogue, or photographs. Narrow lines are recorded for 24 stars; broad lines for 3; wide or peculiar lines, apparently due to duplicity, for 5; composite spectra for 8; and peculiarly strong, dark lines for 2 stars suspected of being dwarfs. The Catalogue occupies fifteen pages of four columns to the page. [See Abstract 2946 (1924).] A. S. D. M.

2653. *The Asymmetry in Stellar Motions as determined from Radial Velocities.* **G. Strömberg.** (Mt. Wilson Observat. Contrib. No. 293. Astrophys. J. 61. pp. 363–388, June, 1925.)—From all available radial velocities the group-motion and velocity-dispersion have been determined for all classes of objects with the aid of ellipsoidal distribution-functions. For spectral classes B0–M the stars have been grouped according to the quantity $H = m + 5 \log \mu$. The constants of the velocity-ellipsoids for fifty groups are given. The results show a continuous change in group-motion with internal velocity-dispersion, which is expressed by a quadratic relation between group-motion along an axis in the direction $\alpha = 309° \cdot 8$, $\delta = + 57° \cdot 1$, and the dispersion along the same axis. The group-motion projected on this axis varies regularly from 9 km./sec. for the Cepheids of long period to 300 km./sec. for fast-moving objects, globular clusters, and spiral nebulæ. The velocity-distribution for the whole collection of objects studied can be expressed as a product of two symmetrical distribution-functions, S_1 and S_2, with different centres of symmetry. The centre of the distribution S_1, which itself is expressed as a sum of concentric, ellipsoidal distributions, corresponds to a velocity of $14 \cdot 8$ km./sec. in the direction $\alpha = 85° \cdot 7$, $\delta = - 22° \cdot 0$, and the centre of the second distribution, S_2, is a velocity of 300 km./sec. in the direction $\alpha = 127°$, $\delta = - 56°$. The opposite vectors are the velocities of the sun relative to these centres. The first distribution can be interpreted as the distribution-law of velocities within our local system of stars and the second as a velocity-restriction in a universal world-frame in which the clusters and spirals are statistically at rest; but other interpretations are also possible. AUTHOR.

2654. *Discovery and Observations of Stars of Class Be.* **P. W. Merrill, M. L. Humason** and **Cora G. Burwell.** (Mt. Wilson Observat. Contrib.

No. 294. Astrophys. J. 61. pp. 389–417, June, 1925.)—Three reasons for studying the spectra containing the emission lines of hydrogen of stars of class B are suggested : (1) Possible assistance in the interpretation of the typical nova spectrum ; (2) the bright lines appear to be sensitive indicators of conditions in stellar atmospheres ; (3) unusual properties of hydrogen atoms may be involved. The discovery of these stars by other observers has usually been made from the $H\beta$ line, but $H\alpha$ serves better because of its greater intensity. By photographing the red portion of the spectrum the authors have discovered ninety early-type stars with hydrogen emission. These are listed. Data concerning the $H\alpha$ line in B*e* stars, as well as in certain nebulæ, Wolf-Rayet stars, and novæ, are contained in tables. The ultra-violet hydrogen lines in the B*e* stars are usually seen in absorption even when $H\alpha$ is bright. Estimates of their intensity are given. The blue-violet portion of the spectrum has been observed with slit spectrographs attached to the large reflectors. Descriptions of $H\beta$, $H\gamma$ and $H\delta$, and various other data, including radial velocities of a few stars, are given. The *Discussion* brings out the fact that the authors' objective-prism spectrograms have yielded more new bright-line stars than the number previously known within the areas observed. It is suspected that in some of these objects the bright lines have come into existence since the Harvard spectroscopic surveys. A study of the distribution of B*e* stars shows a tendency for them to fall into groups near the centre line of the Milky Way. Four of these groups occupy areas which are also rich in Wolf-Rayet stars. The frequency of bright-line stars in the various spectral subdivisions is examined, and classes B0 to B5 are found to be strongly favoured. AUTHORS.

2655. *Luminosity Distribution Law.* **W. J. Luyten.** (Mt. Wilson Observat. Contrib. No. 168. Astrophys. J. 61. pp. 8–27, July, 1925.)—The best material for the derivation of a luminosity law is a systematic survey of the proper motion stars. The frequency function of the reduced proper motions is combined with the correlation between absolute magnitude and reduced proper motion, giving an approximate luminosity law. This may apparently be represented by a normal error curve with a maximum between absolute magnitudes 8 and 9, but of the form of the curve beyond this maximum little is known. Kapteyn has adopted such a luminosity law, but analysis of the data for stars within 25 parsecs shows that near the sun there is an excess of absolutely bright stars. Kapteyn's law seems to predict too many super giants and not enough giants. Analysis of the galactic concentration of different spectral classes makes a universal luminosity law improbable, since the percentage density of A stars rises in the lower galactic latitudes.

A. Wh.

2656. *The Theory of Perturbation and the Perihelion Formula.* **A. Wintner.** (Zeits. f. Physik, 33. 8. pp. 635–642, 1925.)—Using Lagrange's perturbation equations in the form given to them by Gauss, the author arrives at a perihelion formula which differs from the usual one. The value calculated for $\Delta\omega$ comes nearer to Newcomb's 41·24″ than to that calculated from the incorrect formula 48·89″. **Errata,** (*ibid.*, 34. 5–7. p. 547, 1925.) H. N. A.

2657. *Analysis of Radial Velocities of Globular Clusters and Non-Galactic Nebulæ.* **G. Strömberg.** (Mt. Wilson Observat. Contrib.

No. 292. Astrophys. J. 61. pp. 353–362, June, 1925.)—Table I contains a list of all measured radial velocities of globular clusters and non-galactic nebulæ, the great majority of the determinations being by Slipher. The sun's motion relative to the two classes of objects studied is given in Table II in rectangular equatorial coordinates ($-\xi$, $-\eta$, $-\zeta$) and in polar coordinates (A_0, D_0, V_0). The value of the sun's motion relative to the nebulæ is 344 km./sec. toward $A_0 = 305°$, $D_0 = +56°$ and, relative to the clusters, 329 km./sec. in the direction $A_0 = 320°$, $D_0 = +65°$. On the basis of de Sitter's theory of curvature of space-time, we should expect to find for very distant objects a shift of the spectral lines toward the red end of the spectrum. According to Silberstein, we may expect a shift either toward the red or the violet. The correlation-coefficients between distance and radial velocities give no clear evidence of curvature in either de Sitter's or Silberstein's sense, at least up to the limit of distance studied. The only definite correlation is one between radial velocity and position in the sky, indicating a solar motion of 300 or 400 km./sec. in about the same direction for both classes of objects. [See also Abstract 42 (1925).] AUTHOR.

2658. *Meteors.* **F. H. Loring.** (Chem. News, 131. pp. 100–104, Aug. 14, and pp. 117–119, Aug. 21, 1925.)—The connection between comets and meteoric activity is discussed, with particular reference to the Lyrids, Perseids, Leonids, and Bielids. A. W. L.

2659. *Radiometric Determination of the Temperature of Mars in 1924.* **W. W. Coblentz.** (Nature, 116. pp. 472–474, Sept. 26, 1925.) [See also Abstract 2245 (1925).] E. F.

2660. *Proper Motion of Sunspots.* **R. Sekiguti, S. Itiki** and **T. Taguti.** (Imp. Marine Obs., Kobe, Japan, Mem. 2. pp. 25–70, March, 1925. In English.)—The authors use materials from papers by the Maunders (Monthly Notices, 65, 1905) and by Dyson and Maunder [see Abstract 409 (1914)], but confine themselves to the motions and change of area of *regular* spots, taking the differences between consecutive values of longitude, latitude and area, the latter being reduced to a normal scale by representing them in percentage of the maximum area attained during the apparition. They find that a spot tends to maintain its energy according as it is in close connection with the underlying " bed " of slow rotation; that very large proper motion, positive and negative, favours this maintenance; that the rotation is slower than that adopted by Carrington or the Maunders; that it may be ascribed to a layer which is mainly effective in carrying spots. They discuss the levels of different solar phenomena; they suppose two kinds of sunspots, low and high level, and thereby explain the interchange of magnetic polarities of double spots in every eleven years; and find that there is a layer specially favouring the development of a horizontal current near the bottom of the *g*-absorption layer, by which faculæ are constituted. They ascribe the east-over-west effect in spots to the bending westward of the upper part of a vortex filament of a spot by the swift drift in the upper layer; they ascribe the effect in faculæ to an asymmetrical growth, natural in view of the high, swift western drift, and in prominences by a possible difference of temperatures in the western and eastern parts of the sun. A. S. D. M.

LIGHT.

2661. *Origin of Iridescent Colours.* **E. Merritt.** (Optical Soc. America, J. and Rev. Sci. Inst. 11. pp. 93–99, Aug., 1925.)—Deals with the colours of the neck feathers of a pigeon, the wing of a butterfly (*Morpho menelaus*), and polished steel coloured by tempering. Diffused light from a gas-filled tungsten lamp is reflected from the specimen and is studied by means of a Lummer-Brodhun spectro-photometer. The results are thought to show that the colours are due to interference in thin films. In the first two cases the thicknesses are computed to $0{\cdot}208\ \mu$ and $0{\cdot}195\ \mu$, with refractive indices of $1{\cdot}490$ and $1{\cdot}628$ respectively. A few observations on tempered steel were made for comparison. Four graphs are given. W. H. Ge.

2662. *Measurement of Coefficients of Absorption of Light in Fluorescent Substances.* **S. Pienkowski** and **A. Jablonski.** (J. de Physique et le Radium, 6. pp. 177–181, June, 1925.)—This new method is based on the measurement of the fall in intensity of the fluorescence in an exciting pencil of parallel light. The luminous track is photographed and the coefficient of absorption is determined from photometric measurements made upon the plate. The results compare well with those obtained by other methods, and are not affected by variation in the intensity of the light emitted from the source. The method can also be used for measurement in the ultra-violet region. Theory and experimental details are given. W. H. Ge.

2663. *Quantum Theory of Regular Reflection and Refraction.* **R. T. Cox** and **J. C. Hubbard.** (Nat. Acad. Sci., Proc. 11. pp. 498–502, Aug., 1925.)—Ascribing to the quantum the momentum $h\nu/V$, where the symbols have their usual meanings, the principle of least action leads to Fermat's principle, the principle of the conservation of momentum to the laws of radiation pressure and the principle of the conservation of energy to Fresnel's equation for the relative intensities of the incident, reflected and refracted beams. How far the mechanism of radiation is determined by the assumptions that lead to the ascription of this value to the quantum the authors have reached no definite conclusion. G. A. S.

2664. *Method for the Determination of the Reflecting Power of a Metal as a Function of Wave-length and Temperature.* **W. J. Beekman** and **F. W. Oudt.** (Zeits. f. Physik, 33. 10–11. pp. 831–835, 1925.)—The light from a lamp strikes a hot foil of the metal, is reflected and scattered from a white surface placed in front of the slit of a spectrograph. The blackening of the plate thus obtained is due to a mixture of reflected and emitted light, the emission being later determined separately. The comparison of intensities is carried out, using a stepped slit. Full experimental details are given. In all, five exposures are made in each experiment (for instance, in the investigation of Pt foil), *viz.*: (1) Reflection from the cold foil, (2) combined reflection and emission at temperature T, (3) emission of Pt at the same temperature, (4) repetition of the reflection from cold foil, (5) reflection from a calibrated mirror. The

temperature of the foil was measured optically, helium and neon spectra being employed to identify wave-lengths. The final results obtained indicated that the reflecting power of the foil increases with rise of temperature and (in the region investigated, 4800 – 7000 Å.) increasing wave-length. It is also found, however, that the reflecting power of the cold foil is considerably increased by heating to 1300° C., the coefficient being some 5 % greater after the treatment than before, indicating, according to the authors, a structural rearrangement of the metal.
W. V. M.

2665. *The Optical Constants of Magnesium and Zinc Crystals.* **M. E. Graber.** (Phys. Rev. 26. pp. 380–389, Sept., 1925.)—Magnesium and zinc were prepared in the form of hexagonal crystals. Their optical constants (4500 Å. to 6500 Å.) were then determined by the crystalliptometer, polarimetric method. Plane polarised light at an azimuth of 45° was reflected from one of the six faces of the crystal, which was placed successively in two principal positions, in which the principal axis of the crystal was (1) perpendicular, or (2) parallel to the plane of incidence. Two sets of optical constants (index of refraction, absorption index and reflecting power) were thus obtained for each metal. Both indices of refraction for magnesium were found to be less than 0·5 for wave-lengths within the visible spectrum. The indices of refraction for zinc were found to be greater than unity except for the shortest wave-lengths employed. The reflecting powers of both metals agree well with the comparison determinations available. No marked selectivity was found in the optical properties of either metal.
AUTHOR.

2666. *Remark on the Work of A. Ramspeck, "Anomalies of Accidental Double-refraction with Celluloid."* **P. Heymans.** (Ann. d. Physik, 77. 5. pp. 587–588, Sept., 1925.)—Ramspeck pointed out that on account of its anomalies, as described [see Abstract 2715 (1924)], celluloid is not a suitable material with which to carry out experiments when it is wished to draw any conclusion on the distribution of inner tensions. It is here concluded that Ramspeck does not appear to be aware of a large number of works published during the last twelve years on the subject by M. Mesnager, E. G. Coker, L. N. G. Filon, A. L. Kimball, junr., and the author. Further, a part of Ramspeck's work shows a repetition of the work of the authors named.
A. E. G.

2667. *A Relation between the Critical Potentials and the Indices of Refraction of Elements and Compounds.* **B. Davis.** (Phys. Rev. 26. pp. 232–240, Aug., 1925.)—The various dispersion formulæ that have been proposed contain, in addition to one or more constants, terms involving possible natural resonance frequencies in the atoms of the refracting substance. The recent advances following the success of the Bohr atomic hypothesis have led to the specifications of these natural frequencies, and experiment has determined such frequencies in some cases with a considerable degree of accuracy. In particular, the critical X-ray frequencies have been measured with great precision, and recent experiments on the refraction of X-rays in crystals [see Abstracts 579 and 582 (1925)] indicate that the Lorentz dispersion formula represents this refraction with some accuracy. The present paper is an attempt to apply this formula to the calculations of the refractive indices of elements and compounds for visible light. The Lorentz dispersion formula involves critical resonance frequencies. In the case of hydrogen, the observed value of the index of refraction *n* is obtained if the critical resonance potential is assumed to be 16·4 volts. This value is close to the observed ionisation potential. In the cases of Zn, Cd and Hg, the observed values of *n* are obtained if, taking into account the critical potentials of the next inner levels, the following critical resonance potentials for the outer levels are assumed, namely 4·77, 4·38 and 5·21 volts respectively. These values lie in each case between values corresponding to two strong absorption lines. For other gases the observed and assumed potentials are as follows :—

	Carbon.	Nitrogen.	Oxygen.	Sulphur.	Chlorine.	Bromine.	Iodine.
Observed :	11·5, 35	17, 29·9	15·5, 52	12·2, 35	13·2, 46	11·3, 32·6	10, 21
Assumed :	15, 35	17, 29·9	18·5, 52	12·2, 16·2	13·2, 35·3	11·3, 25·8	10, 13·8

The values for the $\mathrm{L_{III}}$ levels of carbon and oxygen agree better with the observed value for nitrogen than do the accepted values, when plotted on a Moseley diagram. However, in the case of He, Ne, and A the observed potentials do not give the observed indices if any reasonable distribution of electrons is assumed. In the calculation of index of refraction of compounds, allowing for heat of formation, the assumption is made that the heat of formation is associated with an equal change of energy of the valence electrons. Thus in the case of water and ice, if the heats of formation are added to the critical potentials of hydrogen, the calculated values of *n* agree within ½ % with the observed. Also, in the case of diamond, a good agreement is obtained only if the heat of formation is included. Data are given for other liquid and gaseous compounds and for liquid carbon and halogen compounds which tend to support this relation. A. E. G.

2668. *Characteristics of Tungsten and the Candle-power of the Black Body.* **C. Zwikker.** (K. Akad., Amsterdam, Proc. 28. 5. pp. 499–502, 1925.)—Gives a table of values of the following characteristics of tungsten at true temperatures from 1200 to 3400° K., *viz.* emissivity ($\lambda = 0\cdot665\ \mu$), brightness temperature ($\lambda = 0\cdot665\ \mu$), colour temperature, resistivity total radiation, brightness, thermionic emission, rate of vaporisation, thermal conductivity, and Thomson-effect. C_2 is taken as 14,330 μ deg., and the gold point as 1336° K. The candle-power of the black body is tabulated for all temperatures between 1300 and 2600° K. The mechanical equivalent of light is deduced as 0·00146 watts per int. lumen.

J. W. T. W.

2669. *Optics of a System in Motion.* **G. Valle.** (N. Cimento, 2. pp. 171–223, April–May–June, 1925.)—A full calculation from first principles. Aberration ; the principle of identical path ; reflection from moving media ; the laws of reflection, observable on a moving system. Applications to Michelson and Morley's experiment. A. D.

2670. *Infra-red Emissive Power of Oxides.* **H. Schmidt-Reps.** (Zeits. techn. Physik, 6. 7a. pp. 322–325, 1925.)—Deals with a method by which the emissive power at well-defined temperatures can be measured. In a set of eight graphs the results for chromium, cerium and thorium oxides and for a mixture of thorium oxide with 1 % of cerium oxide are given. W. H. Ge.

2671. *Ultra-violet Radiation from the Tungsten Arc.* **W. W. Loebe** and **W. Ledig.** (Zeits. techn. Physik, 6. 7a. pp. 325–327, 1925.)—Deals with the transparency of various kinds of glass for ultra-violet radiation in the region of wave-lengths 200–350 $\mu\mu$. As a source of ultra-violet radiation the tungsten arc lamp is superior to the tungsten incandescent lamp provided a pure continuous spectrum is not required. Three sets of spectra photographs are reproduced to illustrate the absorption of five different kinds of glass, the influence of temperature of the tungsten filament and the relative efficiencies of different sources. W. H. Ge.

2672. *Sensitivity of Actinometers with Electrodes coated with Silver Iodide and Copper Oxide.* **G. Athanasiu.** (Comptes Rendus, 181. pp. 101–103, July 20, 1925.)—Reference is made to previous work on the subject [see Abstract 1525 (1925)]. Tables are given showing the variation of sensitivity with wave-length, using N/2 KCl solution as electrolyte and radiations from a mercury arc. Check determinations are also made using the continuous spectrum of the Nernst lamp. With AgI a maximum sensitivity is found at 4245 Å. With CuO electrodes, solutions of NaCl and NaBr are also employed as electrolytes. In all cases sensitivity commences at 5790 Å., reaches a maximum at 4046 Å., a minimum at about 3100 Å., thence increasing again in the direction of the shorter wave-lengths. The positions of the maximum and minimum are independent of the electrolyte and of the mode of oxidation of the CuO. The sensitivity of actinometers made with the same electrodes but with different electrolytes diminishes in the order KCl, NaCl, NaBr. A. B. C. L.

2673. *Universal Portable Photometer.* **A. Blondel.** (Illum. Eng., London, 18. pp. 237–238, Sept., 1925.)—Gives a much fuller account, with four detailed diagrams, of a new form of universal portable photometer based on a modification of the method of Rayleigh. [See Abstract 2480 (1925).] W. H. Ge.

2674. *An Automatic Registration Photometer.* **E. Albrecht** and **M. Dorneich.** (Phys. Zeits. 26. pp. 514–518, Sept. 7, 1925.)—A photometer of comparatively simple design is described which is suitable for continuous working in conjunction with a thermopile, thereby permitting the automatic registration by photographic means of the distribution of the intensities of Röntgen rays within the human body. The instrument can also be used for the evaluation of spectrograms. Full details are included with five diagrams. H. H. Ho.

2675. *The Design of a Cam for an X-Ray Spectrograph.* **J. B. Friauf.** (Optical Soc. America, J. and Rev. Sci. Inst. 11. pp. 289–296, Sept., 1925.)—In photographing X-ray spectra by the rotating crystal method it is frequently desirable to give the crystal such an oscillatory motion that it rotates through a given angle with constant angular velocity, then reverses its direction of rotation and returns with the same constant speed. This type of motion can be obtained from a cam rotating with constant angular velocity. An analytical method is here described which enables the computation of the proper profile for the cam. E. F.

2676. *Measurement of Visibility.* **A. Wigand.** (Zeits. Instrumentenk. 45. pp. 411–416, Sept., 1925.)—A description of the different types of instrument used for determining atmospheric visibility [see Abstract 2395 (1922) and 2043 (1924)]. The theoretical basis underlying the measurement and the method of reduction of the observations are described in detail. J. W. T. W.

2677. *The Scattering of Light by Liquid Boundaries and its Relation to Surface Tension.* **C. V. Raman** and **L. A. Ramdas.** (Roy. Soc., Proc. 109. pp. 150–157, Sept. 1, 1925.)—The paper describes observations and measurements made on the scattering of light by the surface of transparent liquids. About sixty-four substances were tested, and the results bring out clearly the influence of surface tension on the phenomenon of surface scattering, and thus its molecular nature is established. Pure dust-free liquids were specially prepared, and it was found that those liquids showing a small internal scattering are most convenient for surface-scattering observations. The lighter paraffins, ether and the alcohols are typical examples. Other things being the same, a liquid with a higher surface tension shows a smaller surface opalescence and *vice versa*. Transparent liquids show an effect some thirty to fifty times more intense than that observed with metallic mercury. The variation of intensity and state of polarisation of the scattered light with the angles of incidence and direction of observation are given for ethyl ether, and show remarkable results. For light incident normally from above the scattered light in nearly vertical directions is unpolarised, and there is a sudden maximum intensity of light at the critical angle $\left(\sin^{-1}\frac{1}{\mu}\right)$ and a complete polarisation of the scattered light with the electric vector parallel to the liquid surface. With light incident at the polarising angle it becomes completely polarised if scattered upwards, but downwards it exhibits little polarisation in the plane of incidence, but strong polarisation in a perpendicular plane. Light incident at grazing incidence and at various angles from below, as in the case of above, show distinct features duly recorded. Studies of the scattering of light at contaminated surfaces, etc., will be recorded in a later paper. Tables showing the relation between surface tension, refractive index and intensity of scattered red light are given. [See Abstract 2268 (1925).] S. G. B.

2678. *Diffusion of Light by Methane and its Homologues.* **J. Cabannes** and **J. Gauzit.** (J. de Physique et le Radium, 6. pp. 182–198, June 1925.)—Light diffused transversally by the saturated hydrocarbon gases of the aliphatic series is not completely polarised. The factor of depolarisation for methane in daylight is 0·015, and changes but little in passing from methane to ethane, propane, normal butane, normal pentane, isopentane and normal hexane. The results are believed to support the hypothesis that the carbon atom does not possess the exact symmetry of the regular tetrahedron. The intensity of the light diffused transversally by the first four hydrocarbons was compared with that diffused by carbon dioxide. Experimental values are compared with those predicted by the Rayleigh theory in its early form and in a generalised form and with a generalised Einstein theory. Three pages are devoted to a consideration of the asymmetry of the carbon atom. W. H. Ge.

2679. *Depolarisation of Light by Diffuse Reflection.* **G. P. Woronkoff** and **G. I. Pokrowski.** (Zeits. f. Physik, 33. 10–11. pp. 860–869, 1925.)—

Theoretical expressions are obtained for the relative amounts (R) of polarised light obtained when plane-polarised light is diffusely reflected, it being assumed that the part diffused from the interior of the reflector is completely depolarised. When the plane of polarisation is parallel to the reflecting surface, the amount $R\|$ increases continuously with the angle of incidence or reflection; but the proportion $R\perp$ reaches a minimum for a given angle when the plane of polarisation is perpendicular to the reflector. The surfaces tested were magnesia usta and white and coloured Alexandrit papers. Fair agreement is found between experiment and theory in the case of the paper reflectors; the depolarisation decreases as the absorption diminishes. [See Abstract 545 (1925).]

G. E. A.

2680. *Characteristics of Photographic Desensitisers and Distortions on Plates due to Local Desensitising.* **F. E. Ross.** (Eastman Kodak Co. Research Lab. Comm. No. 220. Astrophys. J. 61. pp. 337–352, June, 1925.)—The sensitivity of photographic plates can be reduced by bathing in solutions of certain dyes or certain classes of chemicals. The action is of two distinct types: some chemicals act by oxidising the silver nuclei, others act by catalysis. The first class has the power to destroy the latent image as well as to reduce the sensitivity, while the second class can affect the sensitivity only. The desensitising characteristics of $CuSO_4$, a catalysing desensitiser, have been studied in detail. It is found to be a general characteristic of moderate desensitising to increase the contrast of the plate. A theory of this action is outlined. The characteristics of the dye desensitisers are studied and found to be similar to those of copper sulphate. The oxidising desensitiser, chromic acid, is found to produce a much greater degree of desensitising, due to its ability to destroy the latent image. On the whole, copper sulphate appears to be the most useful and dependable desensitiser. In astronomical photography it is frequently necessary to desensitise small areas near the centre of the plate, as in parallax work. In this case it is of importance to study the distortions produced within the desensitised area. This has been done in detail for various sizes of spots. In general there is found to be a symmetrical radial movement of the gelatine outward within the wetted area, the movement ceasing abruptly at the boundary, where the gelatine is piled up, forming the well-known water-spot ring. This movement ceases at about 19 mm. from the edge of the spot, so that in order to have an area within the spot which shall be free from distortion, the spot must be at least 38 mm. in diam. It is shown that these distortions can be completely eliminated by soaking the entire plate in water immediately after the desensitising bath, which, however, reduces the degree of desensitising. The distortion may also be eliminated by desensitising with chromic acid, applied after the exposure, but this treatment is not recommended. It is concluded that if the desensitised spot is at least 2 ins. in diam., the factor of safety is sufficient for parallax work of the highest precision.

A. E. G.

2681. *Instantaneous Colour Photography.* **G. A. Rousseau.** (Comptes Rendus, 181. pp. 110–112, July 20, 1925.)—When coloured radiations penetrate one or several emulsions rendered sensitive to light by silver bromide, the blue and violet radiations are progressively absorbed, whilst the green and orange radiations—and the orange much more easily than the green—traverse the different sensitive layers and still retain their power of affecting the emulsions if these have been chromatised for these radiations. To apply this theory to photography in colours three films are superposed. The first receives an ordinary slow emulsion, the second an emulsion sensitive to yellow and green, whilst the third has an emulsion sensitive to yellow and red. Further, the second film has one side coated with auramine (yellow) and the other side with fuchsine (pale rose.) The three films are cemented together at the edges and held between glass and metal. In taking a photograph no additional screens are required and existing cameras do not require modification. It is possible to obtain easily good colour photographs with an exposure of 1/25 sec. with F. 4·5 in a good light. A. B. W.

2682. *The Intensity Ratio in the System Debye-Scherrer-Ringen—Its Use in the Investigation of Photographic Processes.* **R. Blunck** and **P. P. Koch.** (Ann. d. Physik, 77. 5. pp. 477–494, Sept., 1925.)—The purpose of this research is principally to work out a kind of photometric measurement arrangement which perhaps may also prove of use for many other kinds of question. A. E. G.

2683. *Photographic Sensitometry with Fluorescent Oils.* **G. R. Harrison.** (Optical Soc. America, J. and Rev. Sci. Inst. 11. pp. 113–123, Aug., 1925.)—The changes in sensitivity and contrast obtained when Cramer Contrast Process, Seed 23, and Wellington super-extreme plates are coated with any one of five different fluorescent oils were studied in the region 2200–3800 Å. for the purpose of improving the precision of photographic photometry in the region 2000–2400 Å., and to investigate the feasibility of extending this method into the extreme ultra-violet. Characteristic curves are given for various plate-oil combinations, and some of the changes in sensitivity and contrast found are tabulated. The effect of thickness of coating was found to be great with most oils; certain oils gave the greatest improvement in sensitivity with thick coatings, and others with thin ones. The greatest sensitivity increase was found with a clear paraffin oil and contrast plates; the greatest contrast was found with a light lubricating oil and the same plates. A 400-fold gain in exposure time by oiling was found in certain cases. Some oils were found to increase the density produced by a certain intensity if the intensity exceeded a certain value, and to decrease it otherwise. This effect varies with wave-length, so that it was found possible to decrease the sensitivity at longer wave-lengths and increase it at shorter wave-lengths, thus making the sensitivity curve of the plate more uniform throughout the spectrum. Although the chief effect with most oils is below 2400 Å., certain varieties increase the contrast even up to 3800 Å., although the sensitivity was generally decreased above 2500 Å. Oiled plates, when the oil coating is uniform, were found to be perfectly applicable to photographic photometry, accuracy to 1 % being readily attainable even at the shortest wave-lengths studied. Sections of the "characteristic surface" in which the reciprocity law holds to within 1 % were found for several wave-lengths, including 2200 Å. AUTHOR.

2684. *Fog Correction in Photographic Densities.* **R. B. Wilsey.** (Eastman Kodak Co. Research Lab. Comm. No. 246. Phot. J. 65. pp. 454–458, Sept., 1925.)—Develops a method of fog correction based on the assumption that the fog over the image is proportional to the mass of the silver unaffected by the exposure. If D_f be the fog correction, D_m the maximum density developable on the plate, D_∞ the limiting image density for the given exposure, and F the fog density in the unexposed area, then $D_f = F(D_m - D_\infty)/D_m$. A method of obtaining an approximate curve of D_∞ : log E for purposes of fog correction is described. It is considered that the method of correction is satisfactory for ordinary sensitometric data, where the fog is not excessive, and where there are no unusual disturbing factors. J. W. T. W.

2685. *Photosynthesis in Tropical Sunlight.* **N. R. Dhar** and **R. P. Sanyal.** (J. Phys. Chem. 29. pp. 926–934, Aug., 1925.)—Baly's statement that there exist in sunlight no rays of very short wave-length capable of effecting the synthesis of formaldehyde from carbon dioxide and water is refuted by the results of the authors' experiments, which show that this synthesis occurs in glass vessels under the influence of tropical sunlight, either in absence or in presence of organic or inorganic solvent. T. H. P.

2686. *Separation of Silver from Silver Halides by Intensive Lighting.* **P. P. Koch** and **H. Vogler.** (Ann. d. Physik, 77. 5. pp. 495–502, Sept., 1925.)—The following points are here considered: Unlighted bromide of silver, strongly lighted bromide of silver, strongly lighted and fixed bromide of silver. Preliminary experiments on chloride of silver similar to those carried out on bromide of silver lead essentially to the same results. Through intensive lighting silver separates in crystal form. With silver iodide it is found that with lighting no separation of silver in crystal form takes place. A. E. G.

2687. *Duration of Fluorescence of Mercury-Vapour.* **R. N. Ghosh.** (Phys. Rev. 26. pp. 376–379, Sept., 1925.)—The theory used by Saha and Sur [Abstract 3043 (1924)] is applied to explain the experiments on fluorescence in mercury-vapour carried out by Phillips, Wood and Vanderlingen. From the nature of the absorption bands and the fact that fluorescence does not occur in a cooling vapour, but only with a freshly formed vapour, it is concluded that the fluorescing molecules must be diatomic. The unstable diatomic molecules given off by the liquid at rising or constant temperature are activated by the absorption of energy per molecule by about 6·7 volts. This energy is radiated out by jumps corresponding to the bands observed. The persistence of the fluorescence is accounted for by assuming that many of the activated molecules transmit their energy to others, not activated, by collisions of the second type. Further, if these activated molecules are mixed with Cs- or K-vapour, they in turn should be ionised, since their ionising potentials are below 6·7 volts. R. S. R.

2688. *The Production of Fluorescence and Phosphorescence by Radiations from the Carbon Arc Lamp.* **W. S. Andrews.** (Gen. El. Rev. 28. pp. 659–661, Sept., 1925.)—Reference is made to much of the earlier work by R. W. Wood on fluorescence, but the apparatus required was costly and dangerous. The author used a more simple and safe arrangement, details of which are given. Tests were made in the region 390–300 $\mu\mu$, the near region of the invisible ultra-violet spectrum, and details are given of the fluorescent colours produced by a considerable number of substances. A further series of tests was made on solids and solutions which were both fluorescent and phosphorescent. R. S. R.

2689. *A Three-dimensional Method of representing Quantum Transitions in Band-Spectra.* **H. B. Lemon** and **C. M. Blackburn.** (Astrophys. J. 61. pp. 61–64, July, 1925.)—A three-dimensional representation of transitions corresponding to radiations in band-spectra constructed for the case of the first negative Deslandres system associated with carbon is described. The advantages of such a model are that, in spite of the several hundred lines involved, such important conceptions as initial and final states, the selection principle and the relation of different subgroups of bands within the entire system are clearly shown. AUTHORS.

2690. *The Intensities of Band Lines.* **H. Hönl** and **F. London.** (Zeits. f. Physik, 33. 10–11. pp. 803–809, 1925.)—The intensities of lines in band-spectra have been considered by Fowler [Abstract 1877 (1925)] and brought into line with the Dorgelo-Burger rules. The present work (entirely theoretical) is a development of these previous considerations, and rules are obtained using the statistical weights of stationary states. Two numerical examples are given and shown to agree with observed values. W. V. M.

2691. *Multiple Electron Transitions and Primed Spectral Terms.* **A. E. Ruark.** (Optical Soc. America, J. and Rev. Sci. Inst. 11. pp. 199–211, Sept., 1925.)—*Excitation of the lines of Mg^+ in low-voltage, low-current discharge.*—The stronger lines of Mg^+ appear at potentials equal to the ionisation potential of Mg plus the excitation voltages predicted from their classifications. This proves that a single impacting electron can ionise an atom and raise a valence electron of the ion to a higher orbit.

Excitation of the pp′ lines of Mg and Cd in low-voltage, low-current discharge.—Using a quartz spectrograph to analyse light from the force-free space between grid and plate, it was found that the Mg *pp′* group (2776 to 2783 Å.) appears at current densities less than 0·2 milliampere per square centimetre. Since these lines are produced by electron transitions from an initial state in which there are two electrons in virtual orbits, this observation shows that the two electrons are moved to these orbits as a result of a single collision; lines which could be produced only by successive impact are entirely absent at much larger current densities. The *pp′* group of Cd (2239 to 2329 Å.) appears at its quantum voltage, but is too faint to be detected at current densities which exclude the possibility of successive excitation.

Several lines of Cd, In, and Tl are classified by the use of primed terms.

Extension of the subordinate series of Cd: spectra of Cd below the ionisation potential.—The low-voltage arc in Cd yielded a number of new lines of the singlet and triplet subordinate series. In exposures taken below the ionisation potential the lines of Cd are excited exactly at the voltage intervals predictable from the classification of the spectrum. AUTHOR.

2692. *Interpretation of Spectra.* **F. Hund.** (Zeits. f. Physik, 33. 5–6. pp. 345–371, 1925.)—Detailed paper, in which, on the basis of Russell and Saunders, Pauli and Heisenberg's work on the co-action of several electrons, the spectral terms of different elements are traced to definite arrangements of electrons, characterised by quantum numbers. Particularly for the elements scandium to nickel, for the normal conditions of the elements and (so far as is known) their positive ions, and for the lower terms of the elements, the quantum numbers of all the electrons are given. Thereby a relation is established between the structure of the complex spectrum and the place of the element in the periodic series; and apparent inconsistencies are removed. A. D.

2693. *Intensity Relations of some Intercombination Spectral Lines.* **T. Bouma.** (Zeits. f. Physik, 33. 9. pp. 658–659, 1925.)—Mercury spectrum; comparison of certain intercombination lines with neighbouring singlet lines. The type $(1P - nd_3)$ gave intensities too weak and diffuse; $(1P - 2d_2)$ and $(1P - 2D)$ gave a ratio 100 : 100; $(1P - 3d_2)$ and $(1P - 3D)$ gave a ratio 42 : 100; $(1P - 4d_2)$ and $(1P - 4D)$ gave 24 : 100. These relations forbid us to consider the lines $(1P - nd_3)$, $(1P - nd_2)$, $(1P - nD)$ as multiplets. A. D.

2694. *Multiplet Structure.* **A. Bramley.** (Phil. Mag. 50. pp. 375–381, Aug., 1925.)—This paper is the continuation of an earlier one [Abstract 1700 (1925)]. The greater part of it consists of tensor analysis. The considerations outlined in the earlier portion lead to the conclusion that only such tubes of paths can exist in the four-dimensional manifold as are multiples of unit tubes. The fundamental quadratic form associated with the motion of an electron with energy H, mass m and charge e about a central charge with mass M and charge E. Then, using the values of H and the periodic time T derived for the simple atom, and where γ is a constant introduced by the change in the units of T, it is found that $H = W[1 - \gamma' . W^{1/2} . n]$ = energy of the electronic orbit, where $W = 2\pi^2 ME^2e^2/n_1^2h^2$ = the highest energy level of the multiplet, and $\gamma' = \gamma(2\pi^2 mE^2e^2)^{-1/2}$. The constant, however, cannot be determined accurately owing to the indeterminations of the scalar gauge vector in the quadratic first integral, which is determined from the electromagnetic field.

If ν and ν' are the frequencies of two lines of a multiplet arising from the same initial state, or ending in the same final state, then $h\nu = H_1 - H_2$, $h\nu' = H_1 - H_2'$; therefore $\nu - \nu' = (H_2' - H_2)/h = \gamma'(n - n')W_2^{3/2}$ = frequency difference of two lines of a multiplet where H_2 and H_2' have the same n_1, but different n's. Thus the frequency separations of the components of the lines of a spectral series of any particular element should vary as $W^{3/2}$, where W represents the highest energy level of the components of the multiplet. Further, the ratio of the frequency separations of the components of any one multiplet should be as the ratio of simple integers, *e.g.* in the triplets of the principal series this ratio is two. Since the values of W for the energy of any one particular level in the optical series for any set of similar chemical elements is nearly constant, the frequency separations of the components of any multiplet should vary as γ' from one element to another similar one. Now this constant should vary as N^2, where N is the atomic number of the element, so that the frequency difference of the energy levels of similar chemical elements varies as N^2, as first stated by Dunz.

The case of the fine structure of the H and He atoms, as well as that of the X-ray spectra considered by Sommerfeld, is a degenerate case of the mathematical theory outlined in the paper, where *s* and *t* become identical. The space then degenerates into a three-dimensional spatial manifold, and the invariant integrals become the usual quantised integrals. The theory outlined applies only to the optical spectra of the elements with more than one electron, since the constant γ depends on the dynamical properties of the inner core, *viz.* on the nucleus and the inner electrons. The introduction of the "inner quantum number" *n* arises through the rotational motion of this inner core with respect to the observer. A table at the end of the paper contains the computed and experimental frequency differences for the energy levels of the spectra of potassium, calcium ionised, calcium. G. W. DE T.

2695. *Intensity of Zeeman Components of Multiplets.* **W. C. van Geel.** (Zeits. f. Physik, 33. 10–11. pp. 836–842, 1925.)—The theory of the intensities of the Zeeman components of multiple lines has been developed by Hönl [Abstract 1411 (1925]), while Ornstein and Burger [Abstract 1360 (1925)] have given empirical rules for the intensities of simple triplets. The Ornstein-Burger rule (already verified for the Zn triplets) has also been shown experimentally to agree with the intensity distribution in the Mg triplets (λ 5167, 5172, 5183). The calculated ratio for the sums of intensities of the components are 1 : 3 : 5 and the experimental values 92 : 289 : 473. The theory was also tested in the case of the Mn octets. The ratios predicted for the π (parallel) components are fully verified. The influence of the polarisation produced by the grating is shown to amount to an intensity correction of 50 %, the polarisation being a function of λ, but remaining constant over the small region investigated. Again, using the Dorgelo-Burger rules, the ratio of components of triplets, septets and quintets were calculated and verified experimentally, in each case agreement being very close. W. V. M.

2696. *The Excitation of Forbidden Spectral Lines.* **P. D. Foote, T. Takamine** and **R. L. Chenault.** (Phys. Rev. 26. pp. 165–175, Aug., 1925.)—Shows that a breakdown of the azimuthal quantum number rule, either with or without a breakdown of the inner quantum rule, is not infrequent, and that forbidden lines are produced in absorption and under other circumstances where there is no strong homogeneous electric field. Violations of the inner quantum rule alone are rare. The authors have used a heated discharge tube 30 to 100 cm. long, with a potential drop of the order of 100 volts between a hot tungsten or coated platinum kathode and a ring anode, so that the electric field was weak, and have found a few such lines in the spectra of Hg, Cd and Zn with no strong magnetic field. It is possible that rapidly varying inhomogeneous fields, such as may be produced by neighbouring ions or atoms, might introduce harmonics into the motion such that the forbidden transitions might occur, quite apart from disturbances giving rise to an ordinary Stark-effect; this applies to the first group of forbidden lines. According to Bohr and Sommerfeld, lines violating the inner quantum rule may be produced by means of a magnetic and not by an electric field. From Paschen and Back's experiments 10^8 gauss should be necessary to produce the $1S - 2p_1$ line of Hg; even local or inhomogeneous fields of this magnitude are impossible in a discharge tube, so that the phenomenon is quite different from that observed by Paschen and Back. While the results do not interfere with the selection principles in their general applicability the rapidly increasing number of forbidden lines observed shows that the subject is involved and requires theoretical and experimental investigation of the effect of rapidly varying fields, electric and magnetic. H. N. A.

2697. *Series Spectra of Two-Valence-Electron Atoms of Boron* (B_{II}) *and Carbon* (C_{III}). **I. S. Bowen** and **R. A. Millikan.** (Phys. Rev. 26. pp. 310–318, Sept., 1925.)—By methods previously reported in the identification of lines in the extreme ultra-violet, 13 lines in addition to the *pp'* group of B_{II} have been identified, completing the classification of all lines known to be due to B_{II}. Taking the 4*f* level as 27800 (probably correct to within 200 frequency units), the following term values were obtained for B_{II}: 3*s*, 72930·8; 4*s*, 36655·5; $2p_1$, 165343·9; $2p_{2,3}$, 165362·7; $3p_1$, 59006·5; $3p_{2,3}$, 59010·0; 3*d*, 52054·2; 4*d*, 28640·4; 5*f*, 17795·7; 2S, 194325·9; 3S, 66665·1; 2P, 120929·4; 3D, 48410·3. In the case of C_{III}, 8 lines in addition to the *pp'* group were identified, and taking the 4*f* level as 62600, the following term values were obtained for C_{III}: 3*s*, 146197·2; 2*p*, 331939·2; $3p_1$, 124685·8; $3p_2$, 124698·6; $3p_3$, 124704·1; 3*d*, 114387·2; 2S, 375463·1; 2P, 273111·0. Progression of frequency separations and of screening constants for regular doublets for Li to O is shown in a table for one to six valence electrons. The separation $(2p_2 - 2p_1)$ or $(2p_3 - 2p_1)$ regularly decreases and the constant *s* regularly increases, for a given element, with the number of valence electrons, irrespective of the fact that both doublets and triplets are involved. AUTHORS.

2698. *The Structure of the Red Lithium Line* λ6708. **J. B. Green.** (Optical Soc. America, J. and Rev. Sci. Inst. 11. pp. 213–216, Sept., 1925.)—The lithium line λ6708 was studied under varying conditions of pressure and current in a vacuum arc, and the Lummer pattern was found to be a simple doublet for low vapour densities. As the vapour density increased, each of the components split into two parts, which are attributed to reversal. The two middle components then merged, the distance between dark centres remaining constant, and then, as each of the reversed lines broadened, the merged components became fainter and finally disappeared when the vapour density became quite high, the pattern then resembling that of a single broadly reversed line. McLennan and Ainslee's wide quadruplet pattern must be attributed to incipient Stark-effects. AUTHOR.

2699. *Line Breadths and Absorption Probabilities in Sodium Vapour.* **G. R. Harrison** and **J. C. Slater.** (Phys. Rev. 26. pp. 176–188, Aug., 1925.)—Harrison has recently investigated the shapes of the absorption curves and the intensities of absorption in the principal series of sodium and calculated the relative probabilities of the various transitions involved, using Slater's formulæ, based on his theory of virtual oscillators. The authors have calculated from these data the theoretical "half-breadths" of the lines 2 to 8, together with the half-breadths in frequency units (P/2π), which are proportional to the probabilities. The broadening of the first line is at least 100 times as great as that to be expected from the Stark-effect and collision broadening, and the breadths of succeeding lines decrease rapidly with increasing term number at the saturated vapour-pressures used (450 to 600° C.), a result contrary to that found at low vapour-pressures. This may be due to the presence of a large proportion of diatomic sodium molecules in varying states of stability, which disturbs the absorbing atoms more than an inert gas would, the perturbations being greater the lower the quantum state. It is noted that the chemical constants of sodium and potassium, as determined by Ladenburg and Minkowski, show large discrepancies from the theoretical values, so that they may not be strictly monatomic, under ordinary conditions, and it is suggested that in saturated vapour the number of molecules increases faster than the number of atoms with rise of temperature, so that at 600° C. there may be many more molecules than atoms; this suggests that the energy of dissociation of Na^2 at absolute zero may be negative. H. N. A.

2700. *Wave-lengths and Pressure Shifts in the Spectrum of Magnesium.* **M. Petersen** and **J. B. Green.** (Astrophys. J. 61. pp. 49–60, July, 1925.)—Existing pressure shift data are considered by various writers to be combined with pole shift and perhaps density errors. Their relations to the Stark-effect are similarly qualified. It is proposed to try and eliminate these criticisms from new observations of magnesium. Wave-lengths of some magnesium lines in an arc in air and an arc *in vacuo* are measured against iron standards in the second, third and fifth orders of a 21-ft. concave grating in a Rowland mounting. The sources and procedure are described in detail and the results of the measures of magnesium and iron lines are tabulated. Pressure shifts are deduced from the wave-lengths. The shifts are found to be smaller than existing older data, but not uniformly so. The shifts increase with series term according to some undetermined law. All the experiments seem to show that any curve of shift in terms of a converging value of series position, either in wave-length or wave number, will be asymptotic to the convergence of the series. The shifts of spectral terms are evidently of fundamental importance. No violet shifts are determined. The shifts are in partial agreement with reported asymmetry of Stark-effect, the two discrepancies involving small values. W. V. M.

2701. *The Fine Structure of the Near Infra-red Absorption Bands of Water-vapour.* **W. W. Sleator** and **E. R. Phelps.** (Astrophys. J. ~~61~~. 62. pp. 28–48, July, 1925.)—With the advantage of better gratings it has become possible to extend previous studies of the absorption of radiation by water-vapour. The methods also represent a refinement of those previously employed, particularly in calibrating the spectrometer. The results of this study considerably enlarge our knowledge of the water spectra. Most important are measurements on the bands near 3·11 μ and 6·26 μ. AUTHORS.

2702. *Arc Spectrum of Ni.* **K. Bechert** and **L. A. Sommer.** (Ann. d. Physik, 77. 4. pp. 351–371, Aug., 1925.)—Detailed tabulated paper on singlet systems, triplet system, and intercombinations in the arc spectrum of nickel. Nickel has a structure with numericals not in a straight line. The fundamental term is an *f* term of the triplet system (in accord with the absorption measurements of v. Angerer and Joos). All the terms are inverted; the magnetic moment in the fundamental condition corresponds to five Bohr magnetons. Even in the single lines there are "underlined" and "non-underlined" terms. A. D.

2703. *Fine Structure of Hydrogen Spectral Lines.* **P. H. van Cittert.** (Ann. d. Physik, 77. 4. pp. 372–380, Aug., 1925.)—A polemical paper deprecating the use of Lummer-Gehrcke plates except under special conditions. A. D.

2704. *Wave-lengths of Additional Lines in the Many-lined Spectrum of Hydrogen.* **T. Tanaka.** (Roy. Soc., Proc. 108. pp. 592–606, Aug. 1, 1925.)—An investigation of the weak lines in the secondary spectrum of hydrogen, investigated in conjunction with Richardson. On plates supplied by Merton 565 lines, not previously recorded by Merton and Barratt (Abstract 1595 (1922) were carefully measured. The lines of the oxyhydrogen bands were remeasured and recorded in a table appended. This was done to eliminate any lines due to impurities. No other impurities were found except a doubtful mercury line $\lambda = 3650 \cdot 15$. A detailed table of all the lines measured in the hydrogen spectrum is appended and notes added regarding classification for intensity. S. G. B.

2705. *The Secondary Spectrum of Hydrogen at Higher Pressures.* **I. Sandeman.** (Roy. Soc., Proc. 108. pp. 607–616, Aug. 1, 1925.)—An investigation of the secondary spectrum of hydrogen by photographing an arc between tungsten electrodes in an atmosphere of hydrogen at high pressures presents the possibility of detection of regularities in the secondary spectrum. A band was selected with its head at 4582·58 Å.U. and shading towards the violet. By calculation from the formula of Kramers and Pauli, the initial moment of inertia of the molecule emitting the band is given as $19 \cdot 326 \times 10^{-41}$ gm./cm.^{2}, which agrees with the value predicted by a static model of triatomic hydrogen H_3. The lines of the P, Q and R combination, discovered by Richardson and Tanaka, are also present in the same condition of the arc, and the intensity distribution found for them agrees with that found for the new band. The effective temperature of the hydrogen molecules is presumably higher in the arc than in the Geissler tube, and it would be expected that the length of the series would increase and the maximum intensity of the lines move towards higher values of *m*. Both effects, however, seem to be in the opposite direction. This is the subject of further work. Detailed results are given in tabular form. S. G. B.

2706. *Resonance Lines of Neon.* **G. Hertz.** (Zeits. f. Physik, 32. 11–12. pp. 933–939, 1925.)—Two strong lines found: $735 \cdot 7 \pm 0 \cdot 5$ and $743 \cdot 5 \pm 0 \cdot 5$ Å. Their frequence-difference is 1428 ± 3, and agrees with the difference between Paschen terms 1_{s_2} and 1_{s_4}; they are therefore to be regarded as combinations of the fundamental term with these two terms, and the two new lines are the resonance lines of neon. The Paschen terms 1_{s_3} and 1_{s_5} correspond to metastable conditions of the neon atom, in agreement with Meissner's absorption researches. The two ionisation potentials of neon are 21·47 and 21·57 volts, in agreement with the value 21·5 determined by the electron-shock. A. D.

2707. *The Isotope Effect in Band-Spectra. III. The Spectrum of Copper Iodide as excited by Active Nitrogen.* **R. S. Mulliken.** (Phys. Rev. 26. pp. 1–32, July, 1925.)—Discusses the excitation of band-spectra by active nitrogen, using the method of Rayleigh and Fowler; excited N_2 molecules, in "impacts of the second kind," probably put halide molecules into the various excited electronic states necessary for the emission of band-spectra. Many impacts cause dissociation of the halide molecule, as with CuI the iodine arc line and over 80 lines of the copper arc spectrum were identified; these copper lines also appeared with CuCl, and analogous results were obtained with PbI_2, HgI_2 and $HgBr_2$. It is suggested that the emission of either of the CuX band-spectra follows the transfer of a Cu^+ electron in the polar Cu^+X^- molecule from its normal state to one of a group of low-lying excited states, whose existence can be correlated with the occurrence of the compounds CuX_2, such easily excited electrons being absent in ions, such as Na^+, which form compounds which do not give a band-spectrum. In the case of the alkaline earth halides analogy indicates that the band-spectra are not due to the compounds MeX_2, but probably to MeX, in which the Me must contain a loosely bound valence electron. The wave-lengths of over 260 band heads of CuI were measured. Each $Cu^{63}I$ band was accompanied, where resolution and intensity were sufficient, by a weaker $Cu^{65}I$ band. The $Cu^{63}I$ bands can be arranged in five systems, one in the green, the other four in the blue and violet; the five systems all correspond to a common final electronic state, which is almost certainly the normal state of the CuI molecule. Analogous relations probably hold for CuCl and CuBr. The electronic energies of the excited states are calculated, an energy level diagram is given, and the intensity distribution in the bands is discussed. H. N. A.

2708. *The Intensities of the Zeeman Components.* **S. Goudsmit** and **R. de L. Kronig.** (K. Akad. Amsterdam, Proc. 28. 4. pp. 418–422, 1925.)—Sommerfeld and Heisenberg have given formulæ for the intensities of the Zeeman components in the case of large quantum numbers, using the correspondence principle. The authors have employed two of the formulæ of Sommerfeld and Heisenberg to obtain the formulæ for the intensities in the case of small quantum numbers. H. N. A.

2709. *Intensity of Doublets in Rb and Cs Spectra.* **F. W. Oudt.** (Zeits. f. Physik, 33. 9. pp. 656–657, 1925.)—Measurements of intensities of doublets in the principal series. For Rb in the Bunsen flame the ratio is 1 : 2. For Cs in a coal-gas and air-blast the ratio varies, but in the arc it is 1 : 2. Comparison with Frerichs' measurement of the ratio 1 : 2, for potassium, indicates that for the alkali metals the ratio of the intensities in the doublets of the alkali metals is 1 : 2. A. D.

2710. *X-Rays scattered by Molybdenum.* **P. A. Ross.** (Nat. Acad. Sci., Proc. 11. pp. 567–569, Sept., 1925.)—The author gives results of measurements made of the relative intensities of the radiation scattered from the molybdenum shield of the kathode of a standard tungsten tube and of a water-cooled molybdenum tube. Tungsten radiation scattered from molybdenum at 160° showed a Compton shift of $0 \cdot 047 \pm 0 \cdot 002$ Å., the calculated value being 0·0469. The molybdenum radiation from a tube run at 50 kv. and 10 ma. is also studied, the intense fluorescence completely masking the unmodified line, but the shift observed agreeing well with the theoretical value ($0 \cdot 035 \pm 0 \cdot 002$ Å.) at 110°. W. V. M.

2711. *On the " Shielding Doublets " of the Bowen-Millikan Ultra-violet Spectra.* **A. Unsöld.** (Zeits. f. Physik, 33. 10–11. pp. 843–848, 1925.) —A theoretical investigation of the relationships between the Bowen-Millikan " shielding doublets " and the atomic number. The regularities of X-ray spectra are recognisable in the ultra-violet spectra, but differ in some respects, since in the former $\Delta\sqrt{\nu}$ is a constant, while $\Delta\sqrt{\nu}$ varies rapidly with Z (the atomic number), for the latter and for large values of Z approaches a limiting value. The treatment follows Wentzel [Abstract 2102 (1925)]. Thus, taking the shell radius $\rho = a_0 m^2/(Z + x)$ and $x = 2\cdot7$ for the a levels, it is found that not only can the observed variations of $\Delta\sqrt{\nu}$ be calculated, but also the ionic radii of Ne, Na^+, Mg^{++} . . ., the results being in good agreement with the observed values. It is, however, scarcely to be expected that agreement would be perfect, since in the actual atom the deviations from the ideal homogeneous spherical shell are severe. Results obtained are :—

Ionic Radius in Å.	Calculated.	Observed.
Ne	0·78	0·63
Na^+	0·57	0·52
Mg^{++}	0·45	0·39

Other similar considerations are discussed. W. V. M.

2712. *Ratio of Intensities of Unmodified and Modified Lines in Scattered X-Rays.* **P. A. Ross.** (Nat. Acad. Sci., Proc. 11. pp. 569–572, Sept., 1925.)—One of the questions demanding an answer as soon as possible is that of the ratio of the intensity of the unmodified to the modified line in scattered X-rays and the variation of this ratio with frequency of the incident beam and atomic number of the scattering substance. When this ratio is measured it may indicate whether the electrons in a particular orbit must stand still and scatter according to the Thomson theory, or are free to acquire momentum in a forward direction and scatter according to the quantum laws stated by Compton. The author has therefore studied photographically the relative intensity of unmodified and modified lines, and shown that, with the exception of lead, the ratio of these intensities is proportional to the atomic number, *i.e.* unmodified intensity divided by modified intensity is equal to kN. W. V. M.

2713. *X-Ray Diffracting Power of a Crystal.* **W. Duane.** (Nat. Acad. Sci., Proc. 11. pp. 489–493, Aug., 1925.)—The writer has proposed a theory [see Abstract 2430 (1923)] according to which momenta of the radiation quanta are transferred in multiples of h/a, where h is Planck's action constant and a is the grating space. Epstein and Ehrenfest [see Abstract 1812 (1924)] have extended this theory, and calculated the probability of deflection of a quantum in a given direction. For a large number of quanta this probability represents the intensity of radiation so deflected. The present paper consists of a discussion of the possibility of reversing this process and calculating the density of the diffracting power (or the density of electron distribution) in a crystal from the measured intensities of various reflected beams. F. S.

2714. *Distribution of Diffracting Power in Sodium Chloride.* **R. J. Havighurst.** (Nat. Acad. Sci., Proc. 11. pp. 502–507, Aug., 1925.)—Applying Epstein and Ehrenfest's quantum treatment of the problem of Fraunhofer diffraction to the determination of the distribution of diffracting power in a crystal, Duane deduces an expression for the "electron density" at a point (x, y, z) in the unit cell of a crystal of NaCl, in the form

$$\rho = \sum_{n_1}\sum_{n_2}\sum_{n_3} A_{n_1 n_2 n_3} \cos 2\pi n_1 x/a \cos 2\pi n_2 y/a \cos 2\pi n_3 z/a$$

where n_1, n_2, n_3 are the Miller indices of the different crystal planes multiplied by the number representing the order of reflection ; a is the length of the side of the unit cell ; $A_{n_1 n_2 n_3}$ is the square root of the intensity of the reflection from the plane $n_1 n_2 n_3$ and has the same value for all combinations (plus and minus) of these numbers. The expression really gives the distribution of diffracting power rather than that of electrons, but the term "electron density" is used for the sake of brevity. Using values of A found by Bragg, James and Bosanquet, curves can be plotted showing the variation of electron density along the cube edge, body diagonal, and face diagonal. Along the cube edge and body diagonal there is evidently an alternation of two kinds of atoms, but along the face diagonal all atoms are alike. The different natures of the peaks for the two kinds of atom seem to indicate that in the chlorine atom there is an outer shell of electrons in which some of the electrons remain for a time, but there is no similar shell in the sodium atom. The curves seem to prove spherical symmetry of the atoms. The bearing of the results on the question whether the points of the crystal lattice are occupied by atoms or by ions is discussed.
G. A. S.

2715. *Distribution of Diffracting Power in Certain Crystals.* **R. J. Havighurst.** (Nat. Acad. Sci., Proc. 11. pp. 507–512, Aug., 1925.)—Using the method previously described [see preceding Abstract], curves are deduced showing the distribution of diffracting power in crystals of KI, NH_4I and NH_4Cl, the experimental values used being some of the author's own. The diffracting power of NH_4 is seen clearly to be much smaller than that of K. NH_4Cl has a body centred structure. Along the cube edge is a succession of chlorine atoms. Along the body diagonal is an alternation of two kinds of electronic groups. Attempts to apply a more complex expression to discover the structure of diamond indicate that the available data on the intensities of reflection in this case are unsatisfactory, otherwise the method would be possible. G. A. S.

2716. *Chemical Constitution and X-Ray Spectrum of Sulphur.* **B. Ray.** (Phil. Mag. 50. pp. 505–511, Sept., 1925.)—Examination of the wave-lengths of the K-lines of a great number of sulphur compounds shows that, within the limits of experimental error, the wave-lengths of the rays are the same for sulphur and sulphide compounds on one hand, and for sulphites and sulphates on the other. Considerable differences are exhibited by the two classes of compounds, the lines $K\alpha_1$ and $K\alpha_2$ being shifted to shorter wave-lengths for the latter class at the same time as their distance apart is considerably diminished. For the lines $K\alpha_3$ and $K\alpha_4$ no such shift was observed. A general discussion as regards the theoretical interpretation of the results is given and four photographs are reproduced.
W. H. Ge.

RADIO-ACTIVITY.

2717. *Radio-activity of Certain Cold Springs in the Neighbourhood of Bagnères-de-Luchon.* **A. Lepape.** (Comptes Rendus, 181. pp. 112–114, July 20, 1925.)—The paper gives the results of measurements of the radium emanation contents of a number of springs situated at high altitudes, and discusses the bearing of the observations in relation to similar measurements of surface springs at lower levels in the same neighbourhood :—

Situation of Springs.	Height (Metres).	Temperature (° C.).	Radon 10^{-9} Curie per Litre of Water.
Carrière de Soulan	850	11·5	13·7
Source de la Grange	750	10·5	5·3
Source de la Prairie	870	9·5	3·6
Source de la Sourruilh	730	11·7	1·5
Coume de Bourg	1850	6·0	0·7
Source de la Grotte de Chat	1490	5·7	8·7
Source du Gouffre Marie-Louise	725	11·0	5·0
Source de Salles	625	14·0	0·7
Source de Montauban	750	12·0	0·8

These proportions of radon, which represent minimum values, are relatively high compared with surface springs at lower levels. A. B. W.

2718. *The Compound Photoelectric Effect.* **P. Auger.** (J. de Physique et le Radium, 6. pp. 205–208, June, 1925.)—The author has previously used C. T. R. Wilson's cloud method to determine the direction of emission of the secondary rays, β-rays, or photoelectrons produced in a gas by X-rays [Abstract 2121 (1924)], and he has now studied the first part of their path and found that in almost all cases a " soft " corpuscular radiation is associated with them. With argon the origins of the secondary β-rays show a thickening in the cloud photographs—a white mass due to the formation of ions at this point. Slow β-rays are only able to penetrate a short distance through argon at atmospheric pressure, so that their track is too short to be visible, but if the argon is diluted with hydrogen the range becomes greater, and definite tracks can be seen and measured. This is seen still better in the case of krypton diluted with hydrogen, the tertiary rays being now 1 cm. long with 3 % of Kr, this length being independent of the X-ray voltage, so that with 60 kv. the original (secondary) β-rays are longer than the tertiary, with 30 kv. they are equal, and with 20 kv. the tertiary are longer than the secondary. Two equal quaternary rays are observed with 3 % of Kr, with 60 kv. X-rays, in addition to the tertiary, and the same is true of xenon. The author concludes that tertiary and quaternary rays are produced in the same atom as the secondary ray, the electron of which is shot out from the K level ; an electron drops from the L level to take its place, and the energy is used to shoot out another electron from the L level, giving the tertiary β-ray ; two electrons now drop from the M level to fill up the vacant places in the L level, and the energy from each of these is used to shoot out a quaternary electron, or β-ray, from the M level. The measured lengths of the β-ray tracks agree fairly satisfactorily with this theory. The original paper should be consulted for the detailed theory. H. N. A.

HEAT.

2719. *Distribution of Temperature in Freely Cooling Blocks of Iron.* **H. Schmick.** (Zeits. techn. Physik, 6. 8. pp. 365–370, 1925.)—Remarks are made on difficulties arising in practice with the use of optical pyrometers on account of variation in emissive power and the cooling correction. The case is then investigated of a circular cylinder which is sufficiently long to allow the flow of heat to be considered as radial. Taking the equation $\partial U/\partial t = a^2(\partial^2 U/\partial r^2 + \partial U/r \,.\, \partial r)$, assuming for simplicity that the T^4 radiation law can be replaced by Newton's linear law, and putting in the surface condition $[\lambda \,.\, \partial U/\partial r - hU]_{r=R} = 0$, the solution in Bessel functions is obtained, the constants then being evaluated by the help of Landolt-Bornstein's tables. Curves follow, showing the distribution of temperature in a cross-section of the cylinder after removal of the cylinder from the furnace. The surface temperatures at short intervals after removal from the furnace (when the temperature was 1200° C.) are compared with the mean temperature of the block. The difference between the surface and mean temperatures is found to increase largely with increase in diameter of the cylinder. A layer of slag on the surface of the block is found to hinder cooling considerably. T. B.

2720. *Distribution of Temperature, Passage of Heat and Storage Power in Unilateral and Periodically Heated Walls.* **C. Schwarz.** (Zeits. techn. Physik, 6. 9. pp. 457–464, and 6. 10. pp. 554–561, 1925.)—This is the first part of a mathematical paper in which the author, starting from results given by Gröber in his book "Die Grundsätze der Wärmeleitung und des Wärmeüberganges," endeavours to obtain more complete equations, *i.e.* equations which more nearly agree with the results of actual experience in the heating of ovens and furnaces. The author states that results calculated on the assumption of constant physical properties, such as conductivity, etc., do not agree with practice. He therefore endeavours to take account of the temperature variation of these properties. The effect of lagging the walls of furnaces is also dealt with. The paper is not suitable for a short abstract. **Errata** (*ibid.*, 6. 10. p. 565, 1925). T. B.

2721. *The Atomic Heat Capacities of Iron and Nickel at Low Temperatures.* **W. H. Rodebush** and **J. C. Michalek.** (Am. Chem. Soc., J. 47. pp. 2117–2121, Aug., 1925.)—The atomic heat capacities of iron and nickel were determined at low temperatures in an apparatus similar to that used by Rodebush [see Abstract 2221 (1923)], with a precision of 0·5 %. The results confirm the work of Griffiths and Griffiths on iron, differing from that of Gunther. The values for the two metals are very similar and agree with the theoretical curve of Debye at low temperatures, deviating markedly at higher temperatures, probably owing to the crystal structure of the metal. B. W. C.

2722. *A Method of Determining the Dew-points of Fuel-air Mixtures.* **R. J. Kennedy.** (Bureau of Standards, Sci. Papers, No. 500. pp. 47–63, 1925.)—The paper gives a method for determining the minimum temperature necessary to keep a mixture of hydrocarbon fuel and air, as used in internal-combustion engines, completely vaporised. This minimum temperature is called the "dew-point" of the mixture. By application of the Clausius-Clapeyron equation and certain simplifying assumptions it is deduced that the dew-point T of a fuel with mixture ratio $R'(R' = m_f/m_a$, the ratio of the masses of fuel and air in the mixture) and total pressure P (P being the sum of the partial pressures of fuel vapour and air), $T = K_1/[\log P - \log\left(1 + \frac{M_f}{M_a}R'\right) - K_2]$. In this equation K_1, K_2, and M_f are constants which are characteristic of the particular fuels, M_f being the average molecular weight of the fuel and M_a that of air. An apparatus is described wherewith the experimental determination of the constants is made. It consists of a glass vapour chamber of about 1500 c.c. volume, fitted with stirrer and capillary burette, and immersed in a water bath. One point of the chamber can be cooled below the temperature of the rest, and condensation be made to occur at that point. Values of the dew-point for absolute alcohol (three gasolines, including an aviation gasoline, and three automobile fuels) are given and compared with those obtained by other observers. The results are probably correct to 2° C. or less. T. B.

2723. *Cryoscopic Measurements with Benzene.* **E. R. Jones** and **C. R. Bury.** (Chem. Soc., J. 127. pp. 1947–1951, Sept., 1925.)—Measurements of the depression of freezing-point of a number of organic compounds in benzene, when dry and when containing definite amounts of moisture, are made by means of a Beckmann thermometer. The calculated molecular weights of the solutes agree closely with those previously calculated from a formula by Brown and Bury. Assuming the theoretical molecular weights, the van't Hoff constant for benzene is calculated to be 52·27 and its latent heat of fusion 29·53. No definite evidence is obtained of solvation, azobenzene being a normal solute, and with picric acid and trinitrotoluene the deviation that might be expected, if solvation occurs, is marked by a deviation in the opposite direction, possibly due to association. With triphenylmethane there are indications of solvation. It is found that substances tend to be more abnormal in benzene than in nitrobenzene. [See Abstract 945 (1920).] J. N. P.

2724. *The Equilibrium between Matter and Radiation.* **O. Stern.** (Zeits. Elektrochem. 31. pp. 448–449; Disc., 449, Aug., 1925. Paper read before the Deut. Bunsen Gesell., Darmstadt, May, 1925.)—The paper contains a brief discussion of whether processes exist by which material masses (atoms, electrons, etc.) are transformed into electromagnetic radiation and *vice versa.* Reference is made to modern stellar theory and to the Nernst hypothesis. Assuming the reversibility to exist, the author applies the thermodynamic laws to a zone of dark radiation [see Abstract 1227 (1924)]. He concludes that in order to explain his calculated temperatures, either only one proton and one electron must always arise together, or that particles of small mass originate direct from radiation, which then coalesce to electrons and protons. H. H. Ho.

2725. *Critical Constants and Vapour-pressures of Hydrogen Cyanide.* **G. Bredig** and **L. Teichmann.** (Zeits. Elektrochem. 31. pp. 449–453; Disc., 453–454, Aug., 1925. Paper read before the Deut. Bunsen Gesell., Darmstadt, May, 1925.)—The preparation of hydrocyanic acid from potassium ferrocyanide and aqueous sulphuric acid is first described, following which come details and data of the determination of the critical density and temperature by Centnerszwer's method, the critical pressure by Altschul's method, the saturation vapour-pressures for the temperature ranges 64·8 to 180° C. and − 15·2 to 39·4° C., the surface tension, specific heats of gaseous hydrocyanic acid, and the degree of association of the liquid. H. H. Ho.

2726. *Distribution of Energy in Thermal Radiation and the Law of Entire Equilibrium.* **G. N. Lewis.** (Nat. Acad. Sci., Proc. 11. pp. 422–428, July, 1925.)—Indications are given of the general character of the modifications in existing belief necessitated by the adoption of the author's new principle of equilibrium [see Abstract 1766 (1925)]. Both Stefan's law and Wien's displacement law are shown to be true limiting laws for ideal radiation, but not quite exact for actual radiation. In a system of radiation in thermal equilibrium the activity of the radiation follows exactly the Wien distribution formula. T. H. P.

2727. *Dispersion of Energy in a Standard Aggregate of Gases.* **Ippisch.** (Phys. Zeits. 26. pp. 501–506, Aug. 25, 1925.)—The theory propounded by Gibbs that the greater the number of degrees of freedom possessed by the molecules in an aggregate of gases the smaller is the average difference between the energy of any one gas, and the mean energy of all the gases has been verified for a particular case by P. and T. Ehrenfest, who show that if the elastic forces which tend to restore the atoms to their equilibrium positions are proportional to the first power of the displacement the most frequent energy and the mean energy are given respectively by $e_m = \frac{1}{2}(6\mathrm{N} - 1)\mathrm{T}$ and $\bar{e} = 3\mathrm{NT}$, and thus the dispersion of the energy $d = \frac{(e - \bar{e})^2}{(\bar{e})^2} = \frac{1}{3\mathrm{N}}$, where N = the number of molecules and T the absolute temperature. Thus, with increasing N the dispersion is clearly negligible. Assuming that the elastic force is proportional to the $(2n + 1)$th power of the displacement, the author shows that

$$e_m = \frac{3\mathrm{N}(n + 2) - 1}{2n + 2}\mathrm{T}, \quad \bar{e} = \frac{3\mathrm{N}(n + 2)}{2n + 2}\mathrm{T} \text{ and } d = \frac{1}{\dfrac{3\mathrm{N}(n + 2)}{2n + 2}}$$

equations which reduce to the previous ones when $n = 0$. He shows further that with increasing values of n the dispersion of the energy increases, attaining when $n \to \infty$ twice the value it has in the Ehrenfest case. On the other hand, the most frequent energy and the mean energy both decrease with increasing n, and in the limit each attains the same value, *viz.* half the value for the mean energy in the Ehrenfest case, *i.e.* $\frac{3\mathrm{NT}}{2}$. Since the mean kinetic energy is $\frac{3\mathrm{NT}}{2}$, it follows that when $n \to \infty$ the potential energy tends to vanish. G. A. S

2728. *Vapour-pressure of Nitro-anilines.* **J. F. T. Berliner** and **O. E. May.** (Am. Chem. Soc., J. 47. pp. 2350–2356, Sept., 1925.)—The vapour-pressures of the three isomeric nitro-anilines have been determined. All decomposed to some extent before their boiling-points at atmospheric pressure were reached. The latent-heat equations were derived and correspond very closely with the observed results up to the range where decomposition takes place. The entropies of vaporisation at a concentration of 0·00507 mol. per litre of vapour were determined and show that the molten nitro-anilines are not normal liquids.

W. H. GE.

2729. *Elements of the Kinetic Theory of Gases.* (Engineering, 120. pp. 1–3, July 3; 63–64, July 17; 125–127, July 31; 190–192, Aug. 14, and pp. 251–252, Aug. 28, 1925.)—The exposition of the theory is developed on standard lines, after a brief introduction to the principles of Maxwell's "statistical mechanics," and is extended to include the principal more recently developed branches of general molecular theory, *e.g.* the relationship of viscosity and heat conductivity to the mean free path; the explanation of the ratios between the two specific heats; Planck's hypothesis, etc. Illustrative examples are mainly drawn from the study of the properties of steam. A. B. C. L.

2730. *The Entropy of Supercooled Liquids at the Absolute Zero.* **L. Pauling** and **R. C. Tolman.** (Am. Chem. Soc., J. 47. pp. 2148–2156, Aug., 1925.)—In formulating the third law of thermodynamics Nernst and Planck assumed that a substance at the absolute zero would have the same entropy in the form of a supercooled liquid as in the crystalline form. Lewis and Gibson [Abstract 1622 (1920)] pointed out that owing to the greater indefiniteness in the arrangement of the molecules of the liquid than in the corresponding crystal, the entropy of the supercooled liquid or glass might conceivably be the greater. In the present paper the authors apply the methods of statistical mechanics to the determination of the entropy of crystals and supercooled glasses. The chief results obtained are:—

1. The difference per mole in the entropy S of a substance at the absolute zero in the form of a glass or crystal is given by $S_{glass} - S_{crystal} = R \log a$, where a is a small number increasing with the complexity of the molecule.
2. The exact nature of the quantity a is given by $\phi(N') = ca^{N'}$, which gives the number of ways in which the mean positions of the N′ molecules of a glass can be arranged when the degrees of freedom corresponding to the positional coordinates are excited to the first quantum state, excluding arrangements which could be obtained by a permutation of atoms.
3. The entropy of a perfect crystal at the absolute zero is not dependent on the complexity of the unit of crystal structure. L. L.

SOUND.

2731. *Vibrations of Unsymmetrical Membranes.* **W. L. Lewschin.** (Zeits. f. Physik, 33. 1–2. pp. 155–160, 1925.)—Deals with the resonance curves of loaded unsymmetrical membranes over the range 900–2400 vibrations per sec. The curves show numerous inharmonic maxima. By comparison of the results for the unsymmetrical and the flat membrane it is shown that curvature of a membrane renders it more uniformly sensitive to vibrations of different frequencies. The results have important applications in the theory of hearing and illustrate the influence of the curvature of the drumskin of the ear. Four pairs of response curves are given comparing the unsymmetrical with the flat membrane. W. H. Ge.

2732. *Theory and Interpretation of Experiments on the Transmission of Sound through Partition Walls.* **E. Buckingham.** (Bureau of Standards, Sci. Paper No. 506. pp. 193–219, 1925.)—The principles brought out by W. C. Sabine's work on the reverberation of closed rooms are discussed, and the equations needed for interpreting the observed facts are deduced. The theory of reverberation suggests experimental methods of measuring the acoustic transmittance of panels by means of observations in two closed rooms which are in acoustic communication only through a panel set up as a part of the partition wall between the rooms. The necessary equations are developed for interpreting such experiments and expressing the results in absolute units, so as to give values which are characteristic of the panel alone and independent of the peculiarities of the laboratory where the tests are conducted. The proposed methods are compared with those employed by P. E. Sabine and F. R. Watson, and it is shown that the quantities measured by the different methods are not physically identical. Hence discrepancies are to be expected among the values obtained, although it seems probable that all the methods would arrange any given set of panels in the same order. G. A. S.

2733. *Design and Calibration of a Phonodeik.* **S. H. Anderson.** (Optical Soc. America, J. and Rev. Sci. Inst. 11. pp. 31–44, July, 1925.)—An acoustic oscillograph of the mechanical type has been designed and constructed in which only the natural frequency of the diaphragm needs to be considered, the horn and tension spring being eliminated. The instrument is sensitive enough for the quantitative examination of the quality of musical tones within the range of $C_2 = 128$ v.p.s. to $C_8 = 8192$ v.p.s. Two methods of calibrating the phonodeik have been developed which check each other in a satisfactory manner. The first uses electrically-driven tuning-forks as sources of simple vibromotive forces, and takes as a measure of the sensitivity for a given frequency the linear increase in angular amplitude of the vibrator per unit increase in amplitude of the fork. The second method uses the centre section of a bowed string as a source of complex vibromotive force, in which the relative amplitudes of the component partials are known. [Abstract 296 (1923).] G. A. S.

ELECTRICITY AND MAGNETISM.

THEORY, ELECTROSTATICS AND ATMOSPHERIC ELECTRICITY.

2734. *The Field of Force in Polarised Dielectrics.* **A. Caldi.** (N. Cimento, 2. pp. 125–142, April–May–June, 1925.)—Maxwell's distribution of tensions is not in accord with the fundamental principles of distribution of pressures in an isotropic elastic medium. The author works out, for the special case where the field of force is electrostatic, another system of tensions which is in accord therewith and also with the fundamental laws of electrostriction. His potential function is that of a stratified electric mass with alternating signs following equipotential surfaces, this potential function being calculated for the interior of the strata themselves. A. D.

2735. *Electrical Phenomena in the Atmosphere.* **J. Clay.** (K. Acad. Amsterdam, Proc. 28. 6. pp. 531–535, 1925.)—Observations of the electrical state of the atmosphere, made in Bandoeng, Java. The potential gradient was registered by means of an ionium collector insulated on amber and connected to an electrometer of the Curie type. The graph of diurnal variation has a maximum of 250 volts per metre about 8 a.m., the mean value being about 90. Another smaller maximum occurs about twelve hours later. The time of the first maximum does not agree with Mauchly's estimate of 17 G.M.T. at all stations, which would be about midnight, local time at Bandoeng [Abstract 591 (1924)]. Nor do the observations agree with Ebert's theory that high potential gradients occur after a fall in the barometer. The conductivity of the air was measured by a dispersive method. Generally, the potential gradient has a maximum when the conductivity is at a minimum. G. E. A.

2736. *Turning Moments of Conducting Dielectric Ellipsoids at Rest in a Rotary Electric Field.* **T. Miyazaki.** (Kyushu Univ. Coll. Eng., Mem. 3. 5. pp. 225–266, 1925.)—Ferrari's discovery of rotary magnetic fields in 1888 induced R. Arnò in 1892 to study the parallel phenomenon of rotary electric fields. With regard to the formulæ for the turning moments acting upon dielectrics, there are only three, as far as the author knows. Hertz treated the case of a conducting sphere rotating uniformly about a diameter in a perfectly insulating medium, and in 1881 gave the first formula for the turning moment acting upon the sphere in virtue of the uniform electric field perpendicular to the axis of rotation (Wied. Ann. 13, p. 266, 1881). This was improved by Schweidler [Abstract 634 (1898)] by taking account of the conductivity of the surrounding medium, and his formula was employed by A. Heydweiller (1897) and L. Graetz (1900) for the experimental determination of conductances. Lampa [Abstract 536 (1912)] further developed the formula for a sphere at rest, taking account of the dielectric constant of the sphere and that of the surrounding medium. This formula then includes its two predecessors as special cases. In the present paper the author generalises Lampa's formula successively into formulæ for prolate spheroids, oblate spheroids, and, finally, general ellipsoids.

The author points out that the conductance and the dielectric constant are assumed to be true constants, whereas, in actual media, according to Graetz (*Handbuch*), the former is a complicated function of the current. Moreover, the so-called hysteresis effect is assumed to be zero, but this is very small in conductive media. He makes the remark that "it might not be wrong to say that the utilisation of the rotary electric field depends entirely upon the turning moment." So long as this moment remains small, accuracy is not to be expected in any of the measurements depending upon this factor. But in view of the extremely high voltages now increasingly employed in commercial work, it should, ere long, be feasible to make use of the rotary electric field in engineering practice.

G. W. DE T.

DISCHARGE AND OSCILLATIONS.

2737. *Moved Layers in the Positive Column of Arc Discharges in the Noble Gases.* **C. Samson.** (Zeits. techn. Physik, 6. 7a. pp. 281–284, 1925.)—A form of arc discharge in Noble gases is described in which the positive column consists of isolated layers which move with velocities between 20 and 2000 m./sec. from the anode towards the kathode. Some photographs given show the appearance of these forms of discharge under different conditions. The influence of the nature of the gas, the gas pressure, the width of the tube, and the current strength are investigated. Some tables show that the velocity increases with decreasing pressure and decreasing width of tube. The current strength has hardly any influence. The transition from the layers to the continuous discharge is briefly mentioned. A. E. G.

2738. *Oscillation Phenomena in Gas Discharges of Different Kinds.* **F. Schroeter.** (Zeits. techn. Physik, 6. 9. pp. 404–423, 1925.)—A general account of the work on the subject, the various experimental arrangements and results being shown in diagrammatical form. A. E. G.

2739. *The Mechanism of the Glow Discharge.* **Güntherschulze.** (Zeits. techn. Physik, 6. 9. pp. 446–457, 1925.)—A general discussion of the principal mechanism of the luminous discharge. A complete theory is impossible, but the present paper is an attempt to supply a fairly comprehensive series of relationships between the quantities involved. It is divided into sections (as below), where the principal points discussed are given :—

1. *Motion of electrons in vacuo.*—For a pair of parallel plates at a given distance d apart, the current i between the plates at a difference of potential V is given by $i = \mathrm{CV}^{\frac{3}{2}}d^2$, where C is a constant.

2. *Electrons in monatomic gases* have a mean free path, which on simple assumptions should be 5·66 times as great as that of the molecules, a fact which may have some connection with the anomalous mean free path of electrons observed in such gases as argon at low pressures.

3. *Collision of electrons and gas molecules.*—Consideration of exchange of energy during collisions of elastic and inelastic types.

4. *Movement of positive ions* and their lower velocity and importance as reducing electronic space charge.

Succeeding sections deal with wall effects, simultaneous movements of both types of ions, and phenomena occurring in the electrodes. The paper is a summary of some present knowledge, and must be consulted for details. W. V. M.

2740. *The Theory of the Phenomena at the Kathode during a Luminous Discharge.* **A. Güntherschulze.** (Zeits. f. Physik, 33. 10–11. pp. 810–830, 1925.)—A complete theory of the phenomena at the electrodes during a discharge is, at the moment, impossible owing to ignorance of certain fundamental quantities. An attempt is made, however, in this comprehensive paper to develop the theory as far as possible with the aid of the known properties of the electron and the distribution of electric field between the electrodes. Further, using the curves of Hughes and Klein showing the relationship between the ionisation produced by an electron and its velocity, it is possible to obtain information concerning a number of relationships between such quantities as distance between electrodes, the kathode fall of potential, current density and other variables. The general principles of electronic motions are discussed when (*a*) perfectly elastic collisions between electrons and atoms are postulated (*i.e.* below the excitation potentials); (*b*) when the line emission is produced and the electron consequently loses energy during the collision; (*c*) the electrons have velocities corresponding to voltages greater than the ionisation potentials of the gases used in the discharge. With increasing velocity the diffuse reflection of the electrons decreases and the paths of the former lie more nearly in the direction of the field. For argon the mean free path of the electron is considerably longer than expected on the kinetic theory for slow electrons. The distribution of intensity of field is discussed, and it is pointed out that a general relationship exist between kathode fall (which is independent of temperature and gas-pressure, but depends on the kathodic material and the kind of gas), mean free path of the molecules, ionisation potentials of kathodic materials and the work required to liberate an electron from the metal. The theory of the discharge is fully developed and relationships found between the various variables involved. The paper is itself succinct, and should be consulted for details. W. V. M.

2741. *Short-length Tungsten Arc Characteristics.* **S. H. Anderson** and **G. G. Kretchmar.** (Phys. Rev. 26. pp. 33–43, July, 1925.)—The method used was a dynamical one. Oscillograms were taken giving the current through the arc and the p.d. across the electrodes (4 mm. in diam.), as the latter were uniformly separated. This was accomplished by connecting the cam which separated the electrodes directly to the shaft of the oscillograph drum, so that the exposure on the film was made while the arc gap was being lengthened. From the measurements of the oscillograms, curves are plotted giving p.d. as a function of current for constant gap length of from 0·005 mm. to 0·4 mm., also curves giving p.d. against gap length for different constant current values from 2 to 12 amps. The intercepts of these latter curves on the voltage axis give the "minimal length" characteristic. It is found that (1) for an arc length 0·4 mm., and for shorter gaps where the current is 4 amps. or more, the characteristics are expressed by Nottingham's equation, $E = A + B/i^n$ where $n = 1{\cdot}49$; (2) the value of n for tungsten fits roughly the linear relation of n to the absolute temperature of the boiling-

point of the anode material, suggested by Steinmetz; (3) the minimal length characteristic is expressed by $E = 13\cdot 2 + 1\cdot 05/(i - 1\cdot 75)$, which makes it possible to compute the constants of an ignition or relay circuit so as to eliminate sparking between tungsten contact points.
AUTHORS.

2742. *Spectral Energy Characteristics of the Constricted Mercury-vapour Lamp—an Extremely Concentrated Source of Ultra-violet Illumination.* **G. S. Forbes** and **G. R. Harrison.** (Optical Soc. America, J. and Rev. Sci. Inst. 11. pp. 99–109, Aug., 1925.)—After having determined in a previous investigation [see Abstract 1178 (1925)] the spectral energy characteristics of a high-intensity quartz mercury arc of 8 mm. bore for various conditions of operation, the writers here describe a similar set of experiments with an arc constricted to a tube of 2 mm. internal diameter and 38 mm. long, thus doing away with the outer absorbing layer of relatively cool mercury-vapour. Currents of from ½ to 5 amps. were used, air cooling being necessary between 1 and 2 amps. and water cooling above this point, except at high pressures, when air cooling was necessary even at low currents. Voltage gradients of from 7 volts per cm. to 58 volts per cm. were used. The pressure in the arc, which was of special design, was measured with a mercury manometer, and varied from 29 mm. to 3920 mm. The energy in each of the more important groups of lines was measured with a thermopile, and it was found that this type of arc was of very high efficiency and of tremendous intensity and convenience for slit illumination. Curves are given showing the spectral energy variation with varying current and voltage, and it is shown that approximately the best combination of intensity, efficiency, convenience, and life is obtained at atmospheric pressure, 1-amp. current, and 110 volts with suitable series resistance. No decrease in efficiency with increasing voltage was observed at pressures up to 5 atmos. Where extreme intensities are desired, currents up to 5 amps. may be used, but the life of the lamp is shortened.
AUTHORS.

2743. *The Relation between Current, Voltage and the Length of Carbon Arcs.* **A. E. R. Westman** and **R. B. Walker.** (Am. Electrochem. Soc., Trans. 46. pp. 205–219; Disc., 219–221, 1924.)—By means of oscillograms a determination is made of the relation between current, voltage, and arc length for carbon arcs carrying alternating currents of from 100 to 700 amps. Two distinct types of a.c. arcs, split and silent arcs, are described; the voltage over a silent arc is the same as that found for a d.c. arc of the same length, or 0·99 L, and the corresponding voltage over a split arc is about 18 volts higher. Voltage and current wave-forms of a split arc, before and after a sudden increase in the external resistance, are shown; an equation for "gaseous conduction" and an explanation of the temporary drop in voltage immediately following such a change are developed. A formula is derived to express the current in terms of the kinetic energy of the charged particles. [See Abstracts 1894, 1895 (1924).]
J. N. P.

2744. *Removal of Adsorbed Gas Layers from Glass Surfaces.* **W. Daudt** and **H. Ewest.** (Zeits. techn. Physik, 6. 7a. pp. 329–332, 1925.) —Some dynamical experiments are here described on the gas given off from differently treated glass walls in a high vacuum by means of ionisation manometers. A. E. G.

2745. *Ionisation of Mercury-vapour by Ultra-violet Light.* **G. F. Rouse** and **G. W. Giddings.** (Nat. Acad. Sci., Proc. 11. pp. 514–517, Aug., 1925.)—Steubing [see Abstract 79 (1910)] obtained experimental results which indicated that Hg vapour can be ionised by light from a quartz mercury arc. Later investigators have been inclined to doubt that he observed true vapour ionisation. One reason for this is that, according to the quantum relation $Ve = h\nu$, only light of wave-length 1188 Å. or less should be able in a single process to ionise Hg vapour. Steubing used no wave-lengths below 1850 Å. Also Steubing's experimental conditions seem to have been such that a careful distinction could not be made between a true ionisation of the vapour and a photoelectric effect from the electrodes. In view of these uncertainties, a repetition of Steubing's work has been carried out under better experimental conditions. As the result it is concluded that a hot mercury arc does not produce ionisation in Hg vapour. When a water-cooled mercury arc is used as a light source it is found that for low vapour-pressures the ratio of the currents is practically the same as the ratio of the areas. It appears that a true ionisation of the vapour takes place, and the fact that a cooled arc is necessary shows that to obtain the effect the core of the line 2536 Å. must be present in the exciting light. It is further shown that the effect is not due to the combined action of the 2536 and a $2p_2$ line, but to the 2536 alone. In some of the early observations a combined action seemed to occur. While later work has not confirmed this, there is still a possibility that under certain conditions such combined action may take place. There are, however, other possible explanations of the effect. It is proposed to continue the study of this subject with the idea of working out the details of the cumulative action involved. A. E. G.

2746. *The Ionisation of Hydrogen by Electron Impact as interpreted by Positive Ray Analysis.* **T. R. Hogness** and **E. G. Lunn.** (Phys. Rev. 26. pp. 44–55, July, 1925.)—Using an apparatus previously described in which positive ions formed by impact of electrons of definite energy $(V_1 + V_2)$ are accelerated and then deflected magnetically around a semicircle into a Faraday cylinder, the relative numbers of ions of types H^+, H_2^+ and H_3^+ were measured as a function of pressure from $<0 \cdot 1 \times 10^{-4}$ mm. to 0·006 mm., and also as a function of impact energy $(V_1 + V_2)$ to 60 volts. At low pressures only H_2^+ ions are formed; as the pressure is increased the percentage of H_3^+ increases in proportion to the pressure. In the apparatus used, the percentage of H^+ increased with pressure, but did not exceed 4 %, while the percentage of H_3^+ ions reached 60. These results confirm the conclusions of Dempster and Smyth that the primary process in the ionisation of hydrogen is the ionisation of the molecule without dissociation. The previously measured ionisation potential at 16 volts (confirmed in this work) is that for the formation of H_2^+. Also H_3^+ appears at this potential, but as a result of a secondary process. It appears that the H_2^+ ion is readily dissociated by collision and that the H^+ ion formed may unite with the H_2 molecule collided with or with some other molecule to form H_3^+. The interpretation of ionisation potentials reported by other observers is discussed in the light of these results. The percentage of H^+ ions found was greater even than the percentage of H_2^+, while no H_3^+ ions were observed. Evidently the primary ions H_2^+ are readily dissociated by impact with He atoms. Evidence was found for the ions HeH^+ and also for an ion with $m/e = 6$, perhaps HeH_2^+. AUTHORS.

2747. *Photoelectric Ionisation of Cæsium Vapour.* **P. D. Foote** and **F. L. Mohler.** (Phys. Rev. 26. pp. 195–207, Aug., 1925.)—The method employed was that developed by Kingdon [Abstract 1652 (1923)]. The change in thermionic current with the unresolved radiation from a mercury arc was measured as functions of the applied voltage, filament temperature, and vapour-pressure. The results are given in graphs and tables. The effect was then studied as a function of wave-length, using a monochromatic illuminator. The ionisation per unit flux was found to increase with increasing wave-length to a sharp maximum at the limit λ3184 of the principal series, as is required by the Bohr theory. For longer waves the ionisation decreased, being about 10 % of the maximum at λ3400. The simple theory does not admit of ionisation by wave-lengths greater than λ3184, but the data are in qualitative agreement with the hypothesis that such radiation produces excited atoms which upon collision with other atoms acquire sufficient additional energy to become ionised. A tube of the type employed, with small kathode practically enclosed by the anode, with suitable gases for the range of wave-length involved, may be used as a photometer or may be calibrated to measure intensity of radiation directly. A. W.

2748. *Ionisation produced in Gaseous Reactions.* **A. K. Brewer.** (Nat. Acad. Sci., Proc. 11. pp. 512–514, Aug., 1925.)—The purpose of this paper is to present evidence regarding the formation of ions in reacting gases and to suggest an hypothesis to explain the mechanism of ion formation. When ethy-alcohol and oxygen are allowed to react between gold electrodes, at temperatures below that of ignition, the following facts are observed: (1) The current flowing between the electrodes is proportional to the applied voltage over the range investigated; (2) the change of sign of the charge applied to the reaction chamber changes only the direction of the current, and does not change the order of magnitude; (3) the current increases exponentially with the temperature. When Al electrodes are substituted for the gold the current flowing through the reacting gas becomes barely detectable (the apparatus is sensible to a current of 10^{-15} amps.). Copper electrodes give a current slightly larger than that observed with gold when a negative charge is placed on the hot outer electrode; almost no current is observed when the electrode is charged positively. Glass electrodes give a current for both positive and negative applied potentials, but the current for the negative is slightly larger than for the positive. From these data it is concluded that the ions are formed in the layer of gas in immediate contact with a conducting surface, and not in the gas space between the electrodes, and that both positive and negative ions are formed in equal amounts on the same surface, showing the phenomenon to be ionic and not electronic. It is conjectured that an ion or polar molecule, when coming within a certain distance (about 10^{-4} cm.) of a conductor, charged or uncharged, is drawn towards the surface by the attraction of its electrostatic image in the conductor. In immediate contact with the surface this force is comparable with the force holding ions together in the molecule. Although the exact conditions existing on the surface are not known, it is possible that it is this force that breaks the molecules up into ions, and thus produces the activation necessary for reaction. On this hypothesis ions are formed at or near the surface, and are ejected by kinetic agitation. The rate of recombination of the ions in moving away from the surface is, of necessity, very rapid; this results in a like rapid increase in effective ion concentration upon approaching the surface. A. E. G.

2749. *The Occurrence of Helium and Neon in Vacuum Tubes.* **R. W. Riding** and **E. C. C. Baly.** (Roy. Soc., Proc. 109. pp. 186–193, Sept., 1925.)—The formation of helium and neon when the electric discharge is passed through a vacuum tube containing hydrogen was first discovered by Collie and Patterson [see Abstract 1036 (1913)], but negative results were recorded by Lord Rayleigh, Egerton and many others. With a view to a solution of this direct contradiction further experimental work has been done, at first with negative results. It was, however, suggested by Masson that the positive results might be due to the disintegration of nitrogen, this element being present in the form of nitride as a surface film on the electrodes. Further experiments have confirmed this suggestion. Thus the conclusions arrived at are: (1) When the nitrides of Al and Mg are bombarded by kathode streams the nitrogen atom is disintegrated, and among the products are found helium, hydrogen and neon; (2) the rare gases are occluded in the electrode splash and may be removed when the splash is strongly heated; (3) the results described by Collie, Patterson and Masson have been confirmed, and it would seem that the production of He has its origin in the disintegration of the nitrogen atom; (4) since the occlusion of the rare gas has been found in many cases to be complete, it is probable that in this phenomenon is to be found the explanation of the negative results of other observers; and (5) minor variations of the amounts of rare gases produced are obtained when a hammer break was substituted by a mercury break and a condensed discharge used. W. V. M.

2750. *Apparent Transmission of Low-velocity Electrons through Aluminium Foil.* **H. E. Hartig.** (Phys. Rev. 26. pp. 221–231, Aug., 1925.)—Recently, Schonland and Terrill [see Abstract 607 (1924)], modifying Whiddington's earlier apparatus, and making use of the modern high vacuum technique, have again verified J. J. Thomson's formula for the loss in velocity suffered by kathode particles in passing through thin sheets of metal. Still more recently Terrill (see Abstract 1184 (1925)] has measured the absorption of kathode rays in aluminium sheets and incidentally has obtained additional confirmation of Thomson's formula. Both Schonland and Terrill found, however, that low-velocity electrons, which they called secondary electrons, were present on the emergent side of a foil which was being bombarded, even when the incident velocity was less than the minimum. These secondary electrons could all be stopped by a retarding potential of 30 volts. The investigation here described has for its object the determination of the origin, velocity distribution, and composition of these so-called secondary electrons. Electrons are accelerated from a tungsten filament to a foil F, 0·0003 cm. thick, behind which, at a distance of 1 mm., is a nickel receiving plate P connected to an electrometer. The ratio of electron current reaching P to that reaching F shows a maximum at about 8 volts primary energy, though the position of this maximum shifts somewhat. By using a retarding potential on P, all the electrons reaching P are found to have velocities less than 10 volts (maximum number at about 2 volts), even when the primary bombarding electrons had a velocity of 1600 volts. Apparently aluminium shows a transparent atom effect for slow electrons similar to that observed in rare gases. In addition to slow speed secondaries, the electrons reaching P include photoelectrons from the back side of F, due to X-rays produced by the primaries. The effect with two foils is only 10^{-4} times that through one, and was probably largely photoelectric. The foil cuts down the plate current by an additional factor of 1/10. With a retarding potential (negatively on P), the plate current for primary velocities of over 40 volts is due chiefly to photoelectrons from the plate, while with two or three foils and an accelerating potential the current is due chiefly to photoelectrons from the back side of the foil. With aluminium similar curves are obtained with one foil (negative P) and with two and three foils (positive P), showing breaks at a number of voltages, including two at about 1490 and 1560 volts, which correspond to $K\alpha$ and $K\beta$ lines of Al. No attempt is made to fix these breaks exactly, but this method promises to be useful in studying critical potentials of metals. A. E. G.

ELECTRICAL PROPERTIES AND INSTRUMENTS.

2751. *The Four Transverse Thermomagnetic Effects and their Relations in Certain Metals.* **E. H. Hall.** (Nat. Acad. Sci., Proc. 11. pp. 416–422, July, 1925.)—The author has previously applied his dual theory of electric and thermal conduction to these effects and obtained relations between the four coefficients P (Ettingshausen-effect), Q (Nernst-effect), R (Hall-effect) and S (Leduc-effect) [Abstract 1210 (1923)]. Recently he has measured the various coefficients for the metals Au, Pd, Ni and Co. The results are given in a table and the values of Q and S calculated from the observed values of P and R. The calculated and observed values agree in sign and in order of magnitude. There is an objection to the theory, however, in that it leads to the mean free path of the electron being independent of the temperature. The equation for the Hall-effect due to the free electron stream—*viz.* $R_f = -6\cdot 28l/kT^{\frac{1}{2}}$—is therefore rejected and the idea introduced that in addition to direct conduction the magnetic field produces dissymmetry in electrical conductivity. New relations between the coefficients are derived and compared with the experimental data available from the work of Unwin, Hall, Campbell and Zahn on a variety of metals. The agreement is satisfactory except in the case of bismuth. L. L.

2752. *Electrical Resistance of Thin Films of Organic Liquids.* **S. S. Bhatnagar, M. Prasad, N. G. Mitra** and **D. L. Shrivastava.** (Zeits. phys. Chem. 117. pp. 88–96, Aug. 10, 1925.)—An investigation is made to ascertain if the orientation of thin liquid films of compounds containing polar groups is reflected in the electrical conducting properties of these films. Measurements are made of the resistance of films of a number of polar organic liquids of the order of thickness of 10^{-3} cm. when spread on thin unglazed paper. With any given liquid the resistance is approximately inversely proportional to the thickness of the film, but in all cases the measured resistances are higher than those calculated from the specific resistances and the thickness of layer. [See Abstract 614 (1925).]

J. N. P.

2753. *The Effect of Light on the Behaviour of Selenium Contact Rectifiers.* **E. Merritt.** (Nat. Acad. Sci., Proc. 11. pp. 572–580, Sept., 1925.)—Substances having the property of giving rectifying contacts have usually high thermoelectric powers, and in most cases the rectified current is in the opposite direction to the current produced by heating the contact. The present paper deals with the behaviour of contacts of Se under the influence of light, knife-edge contacts being used. The usual type of characteristic curves are obtained, the resistance being less for a current from Se to the contact point opposite in direction to the current produced by warming the contact. For an applied e.m.f. of 0·1 volt or more the effect of illumination is always to increase the current, but for very small e.m.f.'s and low-resistance contacts illumination often resulted in a decrease in the current from knife-edge to Se, while still increasing the current in the opposite direction. The percentage charge was in all cases least when the current flowed from Se to the knife-edge. A considerable portion of the change is due to the diminution produced by light in the resistance of the mass of the material, but this cannot be the sole cause of change. For alternating currents Austen's law holds, the effect of light being usually to increase the magnitude of the rectified current, but in some cases it may be diminished. M. V. M.

2754. *Photoelectric Primary Currents in Crystals.* **W. Flechsig.** (Zeits. f. Physik, 33. 5–6. pp. 372–390, 1925.)—Measurements of the duration of photoelectric primary currents in crystals (diamond, clear zincblende, unpurified zincblende, cinnabar, and NaCl coloured yellow-brown by X-rays). The questions dealt with are: (1) Gudden and Pohl found (Zeits. f. Physik, 6. p. 248, 1921) that the primary phenomenon was a frictionless movement of electrons, enduring less than 0·1 sec.; the author finds less than 10^{-4} sec.; (2) the author has succeeded in separating this movement from another, excitable by heat or by long-wave light; (3) Gudden and Pohl's results [Abstract 662 (1925)] confirmed; (4) the period within which a substitution-flow sets in is less than 0·1 sec. A. D.

2755. *The Passage of Electrons through Photoelectrically Sensitive Crystals.* **H. Lenz.** (Ann. d. Physik, 77. 5. pp. 449–476, Sept., 1925.)—After an introduction giving the nature of the photoelectric primary currents, the subject is dealt with as follows: The research arrangement for measurement of the Hall-effect; the proof of the Hall-effect and its dependence on tension, magnetic field and current strength. Theory of the Hall-effect in a crystal. Comparison between theory and experiment, calculation of the mean free path, the collision-time and the velocity of electrons. Electron current through the dark part of the crystal. Proof that the electron current through the dark part of the crystal cannot be explained through diffuse reflected light. The abnormal Hall-effect and the fruitless attempt to explain it through orientation of the crystal and unequal lighting. A failure to prove an alteration of diamagnetism through radiation. The shooting into the crystal of kathode-ray electrons.

The dependence on temperature of the photoelectric primary currents from − 191° to 80°. A. E. G.

2756. *Dielectric Relations and Molecular Association.* **Luise Lange.** (Zeits. f. Physik, 33. 3. pp. 169–182, 1925.)—Dielectric constants of certain liquid mixtures are measured, with regard to concentrations and temperatures. The results are discussed in the light of Debye's dipolar theory, taking molecular association into account. The moments of some kinds of dipolars are measured. A. D.

2757. *The Dependence of the Dielectric Constants of Aqueous Solutions on the Temperature.* **L. Kockel.** (Ann. d. Physik, 77. 4. pp. 417–448, Aug., 1925.)—A compensation method, based on Nernst's bridge method, is described for the measurement of dielectric constants down to conductivities of $H = 5 \times 10^{-5}$. The variation with the temperature of the dielectric constants of water and of urea and cane-sugar solutions was determined between 0° and 100°. The results, compared with the formula developed by Debye on the assumption of dipolar electrons, show no agreement with this theory. The agreement with the requirements of the theory of Gans is but little better, and it appears neither of these theories can be taken as representing the facts. The variation of the dielectric constant with the concentration of the solution is of the same order as that found by other experimenters. B. W. C.

2758. *Dielectric Constants of Electrolytes.* **H. Ulich.** (Zeits. Elektrochem. 31. pp. 413–417, Aug., 1925. Paper read before the Deut. Bunsen Gesell., Darmstadt, May, 1925.)—An abbreviated account is given of the investigations detailed in an earlier publication by Walden, Ulich and Warner [Abstract 2359 (1925)]. A summary is given and curves are plotted of measurements of the dielectric constants at different concentrations with solutions of tetrapropylammonium iodide in chloroform, ethyl aniline and tetrachlorethane, and with tetraethylammonium picrate in *o*-dichlorbenzene. The results are compared with those given by some inorganic salts in water. The part played by the orientation of polar groups, the dimensions of their radius of action and the formation of atomic, molecular and ionic complexes and aggregates are further discussed. A formula is derived which expresses the influence of concentration on dielectric constant in terms of the radius of action of the bipoles. The concentrations in gramme mols. per litre which give minimum values of the dielectric constants is found to be related to the dielectric constants of the solvents (ϵ_0) by the formula $V_{\min} = (134 \cdot 4/\epsilon_0)^3$, where $134 \cdot 4$ is an empirically found constant. In comparing the curves of dielectric constants with those of anomalous conductivity a marked parallelism is observed, though the concentrations for minimum conductivity are about thirty times higher than those for maximum dielectric constant. Both effects are related to the formation of complexes, and the differences in the positions of the minima are attributed to the part played by the undissociated molecule on the dielectric properties. J. N. P.

2759. *Potentiometer Arrangement for Measuring Microvoltages at Radio Frequencies.* **A. G. Jensen.** (Phys. Rev. 25. pp. 118–120, July, 1925.)—The arrangement here described and illustrated diagrammetically enables voltages down to about 0·1 microvolt to be measured to within about 1 %. The resistance units are wound non-inductively on a toroid, so as to reduce the lengths of connecting wires to a minimum. Up to frequencies of 3×10^6 cycles, the impedance of such a unit is less than 1 % higher than the pure resistance. The potentiometer is built compactly to minimise capacity effects and for convenient use in the field. A. E. G.

2760. *Two New Selenium Crystal Bridges.* **A. M. McMahon** and **F. C. Brown.** (Optical Soc. America, J. and Rev. Sci. Inst. 11. pp. 221–231, Sept., 1925.)—The construction of two selenium bridges for studying the electrical properties of the well-known acicular crystals of this element is described. The bridges are distinguished by the devices employed to apply the pressure necessary for good contact between the crystals and a form of metallic grid used in both. They have been designed to eliminate difficulties of insufficient sensitiveness and an unsteadiness experienced by previous workers with certain phases of the light effect. The characteristics of the bridges are such that, together, they have a wide range of usefulness. A screw type of pressure device provides a general utility bridge, while a gravity type results in an arrangement which is more suitable for the purpose of exact measurement. When the temperature is maintained constant, variations in the dark current through the first bridge are of the order 10^{-7} amps. where the potential drop is 2 volts. In the second bridge they may be made a hundred times smaller. The grid feature, common to both bridges, brings about a change of current as much as a thousand times that obtained by illuminating a single crystal. A theory of the unsteadiness, observed in the electrical resistance of selenium crystals by several investigators, is presented. It is believed that a steady condition can be secured only when the pressure used to make contact with the crystals is such that their elastic limit is not reached. A number of facts, collected during the development of the bridges mentioned above, are advanced in support of this view. A practical method for complying with the conditions is given. AUTHORS.

ALTERNATING CURRENTS AND MAGNETISM.

2761. *Identical Electrical Networks in Series.* **A. E. Kennelly.** (Am. Phil. Soc., Proc. 64. 1. pp. 1–16, 1925.)—An unsymmetrical electrical network may, for a given frequency and with respect to the input and output terminals, be replaced by an equivalent T or Π. The author considers a number of such networks identical in every respect, and studies their series connections, each network being replaced by its equivalent T or Π. Taking the case of two networks, if A, G and B, H denote the input and output terminals respectively of the first network, and if A′, G′, B′ and H′ stand for the corresponding terminals of the second network, then there are three ways of connecting the networks in series: (1) Back-to-back B connection, with B connected to B′ and H to H′; (2) back-to-back A connection, with A connected to A′ and G to G′; (3) forward connection, with B connected to A′ and H to G′. The results of the three methods of connection are considered in detail. A. H.

2762. *Magnetic Properties of the Ferronickels.* **M. Peschard.** (Comptes Rendus, 181. pp. 99–101, July 20, 1925.)—For a series of ferronickels it is found that over a wide range of temperature those metals with 34·4 to

100 % nickel have reversible magnetic properties and follow Weiss' law closely. Those metals comprised between Fe and Fe_2Ni are also reversible at high temperatures, but below a certain temperature, which varies with the composition, their magnetic properties become irreversible. The Curie constant and Curie point are graphed with the percentage of nickel; the second curve agrees closely with that obtained from Weiss' equation. [See Abstracts 2159 and 2160 (1925).] G. E. A.

2763. *Effect of Tension on Magnetic Properties of Permalloy.* **O. E. Buckley** and **L. W. McKeehan.** (Phys. Rev. 26. pp. 261–273, Aug., 1925.)—The magnetic properties of permalloy are extremely sensitive to mechanical stress [Abstract 2282 (1923)]. Wires of nickel-iron containing 45, 65, 78·5, 81 and 84 % Ni are tested for permeability and hysteresis by a ballistic method [Abstract 2839 (1924)] with tensions up to 10,000 lbs. per sq. in. and in fields up to 10 or 20 gauss (saturation). The permalloy of low nickel contact is, under tension, more easily magnetised and has less hysteresis than when under no tension. Permalloy with 81 % Ni is nearly indifferent to tension in its magnetic behaviour, whereas 84 % permalloy is more difficultly magnetised and has greater hysteresis when under tension. The saturation values of magnetisation are ultimately independent of tension. In the 78·5 % permalloy, under 3560 lbs./in.^{2} saturation is almost complete at 0·2 gauss, and is reached at 2 gauss; the hysteresis loss is only 80 ergs per c.cm. per cycle. This abnormally low loss is not due to any particular orientation of the crystals. As regards magneto striction, permalloy with less than 81 % Ni expands like iron, but permalloy with more than 81 % Ni contracts like nickel. The demagnetising factor for the wires varies from $1 \cdot 6 \times 10^{-4}$ in low fields to zero in saturation fields. G. E. A.

2764. *Contribution to the Theory of Ferromagnetism.* **L. W. McKeehan.** (Phys. Rev. 26. pp. 274–279, Aug., 1925.)—An explanation of the magnetic properties of permalloy requires a revision of accepted ideas of ferromagnetism. It is suggested that in ferromagnetic material the process of magnetisation involves (*a*) intra-atomic changes, presumably changes in the orientation of electron orbits, governed by quantum dynamics and independent of environment; (*b*) interatomic changes (stresses and strains). Hysteresis loss and magnetic hardness are ascribed to the energy required to produce local deformations in atoms or small groups of atoms. The interdependence of (*a*) and (*b*) is described as atomic magneto striction, and the existence of locally compensatory atomic magneto strictions is put forward as the explanation of the high initial permeability and low hysteresis of permalloy. The fundamental differences in the magnetic behaviours of Fe, Co and Ni are attributed to differences in their atomic magneto strictions. G. E. A.

RADIOGRAPHY AND ELECTRO-PHYSIOLOGY.

2765. *Extra-high-pressure Current Rectifiers for Radiology.* **E. P. Vanoni.** (Elettrotecnica, 12. pp. 556–565, Aug. 15–25, 1925.)—The author gives a general review of rectifiers for X-ray apparatus and includes a series of diagrams and oscillograms from personal experiments which clearly show characteristic features of the different types. E. B.

CHEMICAL PHYSICS AND ELECTRO-CHEMISTRY.

2766. *The Adsorption of Silver Salts by Silver Iodide.* **J. S. Beekley** and **H. S. Taylor.** (J. Phys. Chem. 29. pp. 942–954, Aug., 1925.)—Weighed quantities of silver iodide suspensions are shaken in a thermostat with solutions of various silver salts. Equilibrium is established in three to five hours and is determined by measurement of the electrical conductance of the solutions. The order of adsorbability of different silver salts is found to be as follows: benzoate > acetate > nitrite > bromate > naphthalene sulphonate > benzene sulphonate > nitrate > chlorate > ethyl sulphate > perchlorate. While this is not exactly the reverse of the order of solubilities of these salts, the less soluble ones are strongly adsorbed and the more soluble ones weakly adsorbed. The amount of adsorption is increased in presence of increasing concentrations of the extraneous electrolyte, potassium nitrate. It is concluded that the factors which influence the degree of adsorption are: the hydration of the anion, the compatibility of the AgA crystal lattice with the AgI lattice, and the affinity of the solvent for the ion-pair AgA′. Varying degrees of hydration of the anion may account for the fact that the order of adsorption of the salts is not the same as the order of their solubilities. The growth of a crystal in its solution is related to the attraction which the ions in the surface of the crystal have for the ions in solution. J. N. P.

2767. *Derivation of Adsorption Isotherms.* **A. Gorbatschew.** (Zeits. phys. Chem. 117. pp. 129–142, Aug. 10, 1925.)—The theory is developed whereby adsorption is conditioned by the operation of a field of force present at the surface of separation of the solid and liquid or gas, the sphere of action of the attractive forces being not greater than the diameter of the molecules. Each adsorbed molecule is assumed to be held by the same number of lines of force, and the number of such lines at the surface determines the potential. The adsorption forces may be identified with the residual valencies of ions and molecules represented by Langmuir as proceeding from points on the crystal lattice or with Eucken's more physical conception of adsorption centres. The relations determining the magnitude of the attractive forces and the concentrations are treated mathematically. An interpretation is given of the formulæ for the adsorption isotherms of Langmuir, Reichinstein, Schmidt, Williams, Freundlich, Henry and others. J. N. P.

2768. *Adsorption and Schulze's Law.* **H. B. Weiser.** (J. Phys. Chem. 29. pp. 955–965, Aug., 1925.)—Purified sols of arsenious sulphide and hydrous chromic oxide are precipitated in a mixing apparatus with solutions of definite concentrations of different electrolytes, and determinations are made of the relationship between the precipitation value of the electrolytes and the adsorption of the precipitating ions. It is found that with strong electrolytes containing weakly adsorbed precipitating ions and the same stabilising ion, there is a direct relationship between the relative adsorbability of the precipitating ions and the coagulation power of the electrolytes in the sense that the electrolyte containing the most readily adsorbed precipitating ion coagulates a sol in lowest concentration. The amounts of various precipitating ions carried down on precipitating a sol are determined by (*a*) adsorption by the electrically charged particles during neutralisation, and (*b*) adsorption by the electrically neutral particles during the process of agglomeration. The amounts of (*a*) will be equivalent in case the adsorption of the stabilising ions of the several electrolytes is constant or is negligibly small, but the amounts of (*b*) will vary with the nature and concentration of the electrolyte. The adsorption value of various ions approaches equivalence more nearly with arsenious sulphide than with hydrous oxide sols, as is to be expected from the lower adsorption capacity of the former. It is found that Schulze's law that the precipitating power of an electrolyte is greater the higher the valence of the precipitating ion is but little more than a qualitative rule and that the conclusion of Dhar that ions with the lowest precipitating power are adsorbed the most and *vice versa* are untenable. [See Abstract 1940 (1924).] J. N. P.

2769. *New Method of Determining Certain Molecular Dimensions and the Number N, based on a Study of the Surface Equilibrium of Colloidal Solutions.* **P. L. du Noüy.** (J. de Physique et le Radium, 6. pp. 145–153, May, 1925.) [See Abstracts 2852 (1924) and 431 (1925)]. T. H. P.

2770. *Molecular Weight and Solution.* **W. D. Bancroft.** (J. Phys. Chem. 29. pp. 966–972, Aug., 1925.)—The conception that a colloidal solution may behave, in some respects, like a true solution makes it possible to account for the adsorption isotherms with tannin sols or sols of the substantive dyes; the suspended particles do not behave like a phase of constant concentration. In certain respects a colloidal solution is fundamentally different from a true solution. According to Gibbs, an apparent phase is not a one-phase system if the properties are not defined absolutely when temperature, pressure and concentration are fixed; this shows that most colloidal solutions are two-phase systems. A substance which can be filtered out by an ultra-filter is not in true solution; an ultra-filter is a porous membrane showing no marked negative adsorption, *i.e.* no preferential adsorption of the soluent. A membrane with very small pores and negative adsorption will act as a semi-permeable membrane; an ultra-filter differs fundamentally from this. H. N. A.

2771. *The Inter-ionic Attraction Theory of Ionised Solutes. III. Testing of the Theory in Alcoholic Solvents.* **A. A. Noyes** and **W. P. Baxter.** (Am. Chem. Soc., J. 47. pp. 2122–2129, Aug., 1925.)—The activation of ionised solutes in alcoholic solvents is calculated from existing accurate e.m.f. data according to expressions already developed [Abstracts 2169 and 2170 (1924)]. If the expression log $\sqrt{a_A a_B}$ is plotted against $\sqrt{C}$, where a_A, a_B are activations of the ions and C the concentration, a straight line is obtained for very dilute solutions as required by the theory, deviations occurring at higher concentrations. The numerical constant involved—*i.e.* the slope of the line—is always one-third to one-quarter less than the theoretical value at concentrations of 0·01–0·02N, but approaches this value as the concentration approaches infinite dilution. The logarithm of the activation is approximately inversely proportional to the three-halves power of the dielectric constant, thus showing the effect to be electrical in origin. These conclusions are arrived at from the activations calculated for solutions of hydrochloric acid in ethyl alcohol and equimolal alcohol-water mixtures, for lithium chloride in methyl and ethyl alcohol, and for sodium ethylate in ethyl alcohol. B. W. C.

2772. *The Inter-ionic Attraction Theory of Ionised Solutes. IV. The Influence of the Variation of the Dielectric Constant on the Limiting Law for Small Concentrations.* **P. Debye** and **L. Pauling.** (Am. Chem. Soc., J. 47. pp. 2129–2134, Aug., 1925.)—The limiting law derived by the author for the activities of ions at very low concentrations [see Abstract 2328 (1923)], and expressed in a slightly different manner by Noyes [see Abstract 2169 (1924)], is shown mathematically to be unaffected by the variation of the dielectric constant in the immediate vicinity of the ions or by the deviation of the dielectric constant of the solution in mass from that of the pure solvent. In these very dilute solutions of strong electrolytes the value of the ordinary dielectric constant for the pure solvent in mass is to be substituted. The law is confirmed by recent experiments of Brönsted and la Mer [see Abstract 1608 (1924)]. The law is not applicable to solutions of slightly higher concentration, which explains deviations therefrom observed in some experiments. B. W. C.

2773. *The Law of Distribution of Particles in Colloidal Suspensions.* **J. R. H. Coutts.** (Faraday Soc., Trans. 21. pp. 63–65, Aug., 1925.)—An assumption made by Porter and Hedges [Abstracts 219 and 392 (1923)], when investigating the law of distribution of particles of colloidal suspensions, that no contraction or expansion occurs in the formation of a dilute suspension of gamboge in water, is tested to ascertain to what degree of approximation the assumption is justifiable under conditions analogous to those employed in the above work. By means of a pyknometer, measurements are made at 0° C. of the weights of equal volumes of a gamboge suspension and of water. The density of the suspension is found to differ by only 3 parts in 100,000 from unity, and this agrees, within the limits of experimental error, with the density calculated from the concentration and density of solid gamboge. The assumption of Porter and Hedges is thus seen to be a justifiable one, and any deviation must be extremely small. J. N. P.

2774. *Electrolytic Theory of Corrosion.* **F. N. Speller** and **F. G. Harmon.** (Am. Electrochem. Soc., Trans. 46. pp. 313–317; Disc., 317–318, 1924.)—Certain of the considerations advanced by Bancroft [Abstract 3075 (1924)] are discussed. The conclusion is drawn that the electrolytic theory is the best theory of corrosion at our disposal at present, and it is shown that many cases of so-called pure "chemical corrosion" have not been correctly interpreted. As regards accelerated corrosion tests, these must be very carefully carried out if results entirely different from those obtained by ordinary slow processes of corrosion are to be avoided. T. H. P.

2775. *The Influence of Emulsoids upon the Rate of Solution of Iron.* **J. N. Friend, D. W. Hammond** and **G. W. Trobridge.** (Am. Electrochem. Soc., Trans. 46. pp. 283–294; Disc., 294–296, 1924.)—The retardation of the rate of corrosion of iron produced by emulsoids or protective colloids has been found due to adsorption of the emulsoid. As a result a possible method is suggested of treating natural and other waters to render them less corrosive towards ferrous and non-ferrous metals in practice. In the experiments now recorded, small plates of steel were suspended in solutions of lead acetate to which small measured quantities of agar were added. The results show a marked retarding action with rise in concentration. Similar experiments in solutions of copper sulphate exhibited a pronounced retarding influence. Corrosion loss increases with temperature, and the percentage retardation, due to the emulsoid, at first slightly rises with the temperature, but then falls. The deposition of copper on the surface of the plate affords only little protection to the underlying metal. Using dilute sulphuric acid and stationary plates, the retarding effect is readily detected, although if the plates (as discs) are rotated rapidly but little protective effect is observed. The protective action of colloidal food material is considered to be the reason why iron cooking utensils resist corrosion so well. H. H. Ho.

2776. *Film Protection as a Factor in Corrosion.* **F. N. Speller.** (Am. Electrochem. Soc., Trans. 46. pp. 225–237; Disc., 237–240, 1924.)—Silicate of soda is found to have a marked effect on the rate of corrosion of iron in hot water, and a distinct but smaller effect on corrosion in cold water, without entirely stopping corrosion. The protective action results from the formation of a film of colloidal silica, which is formed by hydrolysis, but depends to some extent on the presence of other scale-forming matter in the water. The alkaline silicate, with a ratio of Na_2O to SiO_2 of 1 to 2·25, has been found best for cold water, while anhydrous sodium silicate of composition 1 Na_2O to 3·25 SiO_2 is most effective with hot water. With some domestic waters lime may be used to advantage, if applied with careful control. A description is given of natural protective coatings which are formed under different conditions and of the factors, such as H-ion concentration and the presence of dissolved oxygen, which influence the character and deposition of protective films in water. The influence of H-ion concentration on the solubility and precipitation of calcium carbonate is discussed. J. N. P.

2777. *The Micro-chemistry of Corrosion.* **C. H. Desch.** (Am. Electrochem. Soc., Trans. 46. pp. 241–246, 1924.)—A microscopical study is made of the early stages of corrosion, and a description given of the apparatus employed and of the methods of testing alloys. The process of corrosion is fundamentally electrolytic, and minute differences in the condition of a metallic surface or the presence of traces of foreign substances suffice to initiate the action. Iron rust, for example, differs greatly from iron in electrolytic potential, and therefore provides an efficient kathode. The difference of potential necessary for the setting up of such a system may also be provided by the presence of two distinct phases in alloys of duplex structure, by contact with other conducting substances, or by local differences in the condition of even a pure metal, as when a locally cold-worked region occurs on a metal softened by annealing. The product of corrosion is often colloidal, though the presence of colloids is not considered essential to corrosion. J. N. P.

2778. *Notes on Corrosion Testing by Different Immersion Methods.* **H. S. Rawdon and A. I. Krynitsky.** (Am. Electrochem. Soc., Trans. 46. pp. 359–372; Disc., 372–386, 1924.)—Two forms of immersion tests, the simple or total immersion and the repeated immersion, in which the specimen is withdrawn into the air after being dipped into the solution, are discussed and a description of the apparatus for carrying out such tests is given. The results obtained for a series of chromium steels, varying in chromium content from 2·7 to 19·7 %, and with carbon content varying from 0·06 to 1·44 %, are summarised to show the differences which occur in the two types of immersion tests in distilled water. The greater resistance observed for the steels tested by intermittent immersion in water, as compared with simple or stationary immersion in the same medium, appears to be associated with the presence of a surface film, which forms more readily under the conditions of the former test than under those of the latter. The results obtained in a series of simple immersion tests of the same chromium steels, in dilute hydrochloric acid and in citric acid, are also included. These indicate that for the test conditions used, the result of the immersion tests in one acid is not an index of what may be expected in the other, nor of what is found for the same steels in the distilled water test. **J. N. P.**

2779. *The Electrolytic Corrosion of Ferrous Metals.* **W. M. Thornton** and **J. A. Harle.** (Faraday Soc., Trans. 21. pp. 23–32; Disc., 32–35, Aug., 1925.)—Corrosion tests on a number of samples of iron, steel and iron alloys are made by an electrolytic method on the assumption that this provides the most direct way of subjecting a metal to the influence of active moist gas. The specimens are made the anodes of cells containing slightly andulated water. On passing definite amounts of current, the loss of weight is determined after removing any adhering oxide. The curves showing the loss of weight plotted against current are generally linear, showing that there is no skin effect in anodic corrosion. In the case of ordinary steels the amount of corrosion is found to be greater than that corresponding to the electro-chemical equivalent demanded by FeO. Pure iron appears to oxidise quantitatively to Fe_3O_4. In alloys of high nickel content the corrosion is reduced to nearly a fifth of that of wrought iron, and rustless steels have a corrosion of one-thirteenth of that of pure iron. The different alloys may thus be identified by these characteristic rates of corrosion. **J. N. P.**

2780. *Corrosion of Iron Alloys by Copper Sulphate Solution.* **C. M. Kurtz** and **R. J. Zaumeyer.** (Am. Electrochem. Soc., Trans. 46. pp. 319–328; Disc., 328–330, 1924.)—Results are given of tests of the corrodibility of a number of alloys made from electrolytic iron, the metal being treated with acidified copper sulphate solution. The alloys containing chromium appear to be the most resistant. When only chromium is alloyed with the iron, it must form at least 10 % of the alloy to cause effective resistance to the action of the liquid. A 6 % chromium alloy may be made resistant by addition of either 18 % of tungsten or 14 % of nickel. A 10 % chromium alloy is not affected by amounts of carbon less than 0·31 %, but 0·4 to 0·65 % causes deposition of the copper, although this may be prevented by heat treatment. When 15 % of chromium is present, 1 % of carbon causes no deposit. At least 45 % of nickel is required to produce resistance to corrosion. Addition of 10 %, but not of 5 % of molybdenum to a 10 % chromium alloy exerts a protecting action; manganese seems to be without any effect. **T. H. P.**

2781. *Tests for Grading Corrosion-resisting Alloys.* **W. E. Erickson** and **L. A. Kirst.** (Am. Electrochem. Soc., Trans. 46. pp. 339–345; Disc., 345–347, 1924.)—The application to the surface of a metal of an acidified copper sulphate solution recommended by Kurtz and Zaumeyer [see preceding Abstract] is probably sufficient to detect all alloys having marked resistance to corrosion, but does not differentiate between those of high and those of only moderate resistance. Such grouping of alloys according to their resistances to corrosion may be effected by the use of solutions of silver nitrate and of platinum, gold and palladium chlorides. Of the common elements, silicon and chromium appear to be the most resistant to corrosion, and the addition of either of these elements to iron reduces its corrodibility very appreciably. T. H. P.

2782. *Equilibria in the System Zinc Sulphate-Water.* **E. Cohen** and **A. L. T. Moesveld.** (K. Akad. Amsterdam, Proc. 28. 5. pp. 461–466, 1925.)—An error in the work of Cohen [Abstract 2278 (1900)] is indicated and the existence of metastable, monoclinic, heptahydrated zinc sulphate between 7° and 35°, pointed out by Bury [Chem. Soc., J. 125. p. 2538, 1924], is confirmed. T. H. P.

2783. *The Red-shortness of Iron; Influence of S, O, Cu and Mn.* **J. R. Cain.** (Am. Electrochem. Soc., Trans. 46. pp. 133–145; Disc., 145–147, 1924.)—Ingots of electrolytic iron and also of Armco iron, each weighing 900 g. and containing finally small amounts of Mn (up to 0·02 % in the electrolytic iron), O (up to 0·2), S (up to 0·022), Cu (up to 0·5), were remelted in a vacuum or an induction furnace. Bars forged from the ingots were reheated to 1000° in a forge, quickly withdrawn and bent back and forth through 180° with a hammer over the sharp edge of an anvil until they broke at a temperature which was not determined. Most of the specimens did not break at dull red-heat. The subsequent analysis indicated that there was no red-shortness as long as the sulphur percentage did not exceed 0·01, even when 0·2 % of oxygen (Ledebur method) were present. A ratio of Mn/S greater than 3 prevented red-shortness even with S above 0·01; copper had a weaker preventive effect. In the *Discussion,* **B. D. Saklatwalla** mentioned that sulphur and sulphides added had a different effect from residual sulphur in the refined iron. The author replied that his electrolytic iron contained only 0·004 S, but took up more sulphur during remelting from the magnesia or zirconia crucible; nitrogen was probably absent. H. B.

2784. *Stainless Steel.* **W. H. Hatfield.** (Am. Electrochem. Soc., Trans. 46. pp. 297–307; Disc., 307–312, 1924.)—A *résumé* of present knowledge as to the behaviour of stainless steel when exposed to various corroding media, and a suggested explanation for some anomalies that are observed. A list is given of (*a*) reagents which have little or no action on stainless steel, and (*b*) those which attack it more or less readily. In the *Discussion,* **C. G. Fink** pointed out that for a steel to resist corrosion at temperatures of the order of 800° C. it was necessary to increase the chromium content up to 40 %. J. L. H.

2785. *Preparation of Pure Alloys.* **R. F. Mehl.** (Am. Electrochem. Soc., Trans. 46. pp. 149–176; Disc., 176–180, 1924.)—Sources of contamination in the preparation of alloys for metallographic investigation are pointed out and a method of making pure magnesia crucibles is described. A furnace for making alloys and casting them into rods suitable for the measurement of electrical properties is also described. A study of the β and $\beta + \gamma$ regions in the aluminium-magnesium series of alloys is undertaken by means of electrical resistivity and thermo-electromotive force. J. L. H.

2786. *Partition of Silver between Lead and Zinc.* **W. A. Naish.** (Faraday Soc., Trans. 21. pp. 102–113, Aug., 1925.)—The "partition coefficient" (*i.e.* % Ag in Zn ÷ % Ag in Pb) of silver, in proportions varying from 1 % to 3 %, in mixtures of lead and zinc, is determined for varying conditions of temperature, time of stirring, and time of settling. Micrographic examination is found to be useful in determining the correct conditions for equilibrium of the layers. In dilute solutions the partition coefficient is independent of the concentration of the silver and also of the proportion of lead to zinc, but is dependent on the temperature, the formation of silver-zinc compounds being suggested as the cause of deviation from this law at higher concentration. The average value of the coefficient at 550° C. is 301·9. Application of van't Hoff's expression for the calculation of Q yields consistent results when definite compounds are absent and over the lower range of temperatures. A. B. C. L.

2787. *Activation of Hydrogen by excited Mercury Atoms.* **A. C. G. Mitchell.** (Nat. Acad. Sci., Proc. 11. pp. 458–463, Aug., 1925.)—It has been shown in various ways that mercury atoms, when excited by absorbing vibrational energy of wave-length 2537 Å., are able to activate various kinds of atoms by collisions of the second kind [Abstract 783 (1923)]. The experiments of Dickinson on the effect of activated hydrogen on oxygen are repeated and extended to determine the effect of the gaseous pressures. A known mixture of the gases, along with diffused mercury, is subjected to the rays from a mercury arc. The effect is gauged by the change in pressure noted when the condensible material is withdrawn after ten minutes' illumination. With oxygen at about 0·04 mm. the rate of reaction increases to a maximum with increase of pressure of hydrogen. Similar behaviour is noted when the hydrogen pressure is kept constant at 0·04 mm.; the maximum rate of reaction occurs when the oxygen pressure is about 0·01 mm. The addition of relatively large quantities of argon stops the reaction completely. G. E. A.

2788. *Catalytic Oxidation of Hydrocyanic Acid.* **R. Hara** and **H. Sinozaki.** (Tôhoku Univ., Technol. Reports, 5. 2. pp. 1–43, 1925. In English.)—Deals with the oxidation of HCN to NO with a platinum net used as a catalyser in the range of gas velocities 20–1120 c.c., 0° C., 760 mm./sq. cm./min., between temperatures 400–1000° C., and with HCN concentrations in an air mixture of about 2–40 %. Yield-temperature curves show that the oxidation begins fairly abruptly at about 450–500° C., almost independently of the gas velocities, and generally at 600°–800° C.; 85–95 % of HCN can be easily oxidised into NO. Above 800° C. there is a certain temperature, depending greatly on the gas velocity, at which the yield of NO begins to drop. Between 500°–800° C. the isothermal yield-gas velocity curves are almost straight lines, which gradually ascend with increase of gas velocity. Above 850° C. the curves are not straight lines. Isothermal yield-HCN concentration curves show that with HCN concentrations of about 4–8 % the yield of NO is high, but with higher concentrations the NO yield quickly decreases. With a 30 % concentration the HCN is not oxidised into NO, but chiefly into a solid product consisting mostly of cyanuric acid ($H_3C_3N_3O_3$) and cyamelide ($(HCNO)_n$). The main reaction of the production of NO is thought to be $2HCN + 5O = 2NO + 2CO + H_2O + 138100$. The whole mechanism is discussed in detail. Comparison with the catalytic oxidation of ammonia from the chemical and technological standpoint has been made. The paper is illustrated with diagrams of the apparatus and five graphs. W. H. Ge.

2789. *The Condensed Ternary System: Phenol-Water-Salicylic Acid.* **C. R. Bailey.** (Chem. Soc., J. 127. pp. 1951–1965, Sept., 1925.)—Solubility relations and the eutectic points for the binary systems (phenol-water, salicylic acid-water and phenol-salicylic acid) are investigated by the analytic method, whereby the mixtures are stirred in a thermostat and the composition of the one or two liquid layers is determined. The ternary system is also explored by the synthetic method, in which varying amounts of salicylic acid are added to known mixtures of phenol and water and the temperatures of sudden thickening and that of opalescence are determined. Curves are then constructed showing the relation between the above temperatures and the concentrations of salicylic acid in the particular mixture. From these curves the isotherms are plotted on a ternary diagram. The measurements are extended well into the metastable region. The properties of binodal curve relations are considered in detail. The solubility of salicylic acid is seen to be much greater in the mixed solvents than in either alone. J. N. P.

2790. *Physical State of Catalysts.* **R. C. Smith.** (J. Phys. Chem. 29. pp. 1116–1118, Sept., 1925.)—Experiments on the decomposition of hydrogen peroxide by platinum, gold, and palladium previously polished and also polished and re-heated sufficiently to restore crystalline structure tend to show that catalytic activity is due rather to the state of the catalyst than to its specific surface, the amorphous state being the more active. A. B. C. L.

2791. *The Catalytic Decomposition of Hydrogen Peroxide in an Acid Chlorine-Chloride Solution.* **R. S. Livingston** and **W. C. Bray.** (Am. Chem. Soc., J. 47. pp. 2069–2082, Aug., 1925.)—The chlorine-chloride decomposition catalysis rate of hydrogen peroxide is measured at 25° in solutions of hydrochloric acid of 0·06 to 4·80 and also with additions of sodium chloride or perchloric acid. An equation is developed for the "steady"-state decomposition rate in solutions of ionic strength less than 1·0, which is more in accord with the observed facts than others tested; an expression is also derived for the steady-state concentration. The mechanism of the reaction appears to be analogous to that found for the bromine-bromide catalysis. An equation is also developed connecting the time required for the chlorine concentration to reach any fraction of its steady-state value with the initial concentrations of hydrogen peroxide and hydrochloric acid. B. W. C.

2792. *Action of Acid Solutions of Low Concentration on Ferrous Metals.* **R. Girard.** (Comptes Rendus, 181. pp. 215–218, Aug. 3, 1925.)—Results are given of investigations on the action of solutions of sulphuric, hydrochloric and carbonic acids, and phenol, of different concentrations on cast iron and steel. For any given acid, the two metals are almost equally attacked. When the concentration is very low, the corrosion depends on neither the concentration nor the nature of the acid, and remains constant for a given content of dissolved oxygen, which is the essential factor. At a certain concentration, depending on the nature of the acid, the action is accelerated, the value of *p*H when this occurs being greater with weak than with strong acids; with the latter the acceleration is sudden, but with the former gradual. At a certain critical concentration of the order 10^{-3}N the increase in the corrosion becomes very rapid, and at similar concentrations is greater for strong than for weak acids; thus the determining factor is the concentration of the hydrogen ions. T. H. P.

2793. *Films of Platinum and Nickel and Catalytic Activity.* **A. W. Gauger.** (Am. Chem. Soc., J. 47. pp. 2278–2282, Sept., 1925.)—Thin films of platinum and nickel prepared by evaporation in a vacuum and condensation on Pyrex glass wool in a tube immersed in liquid air are found to be devoid of catalytic activity towards the reaction $H_2 + C_2H_4 = C_2H_6$, in either presence or absence of oxygen or water-vapour. T. H. P.

2794. *Thermodynamics of the Quinhydrone Electrode and the Chemical Constant of Hydrogen.* **E. Schreiner.** (Zeits. phys. Chem. 117. pp. 57–87, Aug. 10, 1925.)—A thermodynamic investigation is made of the quinhydrone electrode with a view to determine its applicability, the validity of the Nernst heat theorem, and the value of the chemical (integration) constant of hydrogen. From data on the molecular heats of quinone, hydroquinone, and quinhydrone over a large range of temperatures a calculation is made of the total and the free heat contents of these compounds and of hydrogen. E.M.F. measurements are made with the elements:—

Pt^{+}/(*a*) hydroquinone or (*b*) quinone, quinhydrone/electrolyte/H_2/P^{-},

using sulphuric acid or acetic acid and sodium acetate as electrolyte at different temperatures. The operation of a neutral body effect with these electrodes is made evident through the influence of quinhydrone and its components on the H-ion activity. The corrected voltages and their temperature coefficients are employed in the calculation of the affinities and heat changes of the reactions: Quinhydrone + H_2 = 2 hydroquinone, and 2 quinone + H_2 = quinhydrone. By means of these data and those of the molecular heat estimations, the chemical constant of H_2 is estimated from the above reactions to be from 1·09 to 1·11. From the reaction quinone + H_2 = hydroquinone, the constant is evaluated at 1·01. On the assumption that H_2 behaves kinetically as an ideal diatomic gas down to absolute zero the so-called normal chemical constant of hydrogen is calculated to be $- C_{H_2} = 3{\cdot}71$. Direct measurements of the heats of combustion of quinhydrone and hydroquinone agree with the values deduced from the Nernst equation. [See Abstracts 2549, 2614, 2640, 3092 (1924).] J. N. P.

2795. *Studies of Electrolytic Polarisation. Part III. The Diffusion Layer.* **S. Glasstone.** (Chem. Soc., J. 127. pp. 1824–1831, Aug., 1925.)—The thickness of the diffusion layer—the layer of electrolyte of special concentration covering the electrode or the surface of the reacting solid—is assumed to be independent of the concentration and, as long as there is no disturbance by gas liberation, also of the current density. When gas is liberated, the author shows from his previous [Abstracts 462 and 1272 (1925)] and new experiments with lead and mercury kathodes, the difference between the direct and the extrapolated over-voltage, which is presumably due to the resistance at the electrode surface, is not nearly proportional to current. This indicates that the resistance changes with the current when gas bubbles are evolved, and that it decreases as the current is increased. The resistance is largely due to the presence of a thin layer of dilute electrolyte in immediate contact with the electrode, and the thickness of this layer probably decreases as the current density is increased. This is confirmed by experiments with a mercury kathode in sulphuric acid containing potassium sulphate and with mercury and platinum electrodes in hydrochloric acid saturated with chlorine. Porous diaphragms are sometimes used. The back e.m.f. first increases for 0·002 sec. after switching-off the polarising current and then decreases. The thickness is not estimated by other methods. H. B.

2796. *Overvoltage and Surface Forces at the Lead Kathode.* **S. Glasstone.** (Faraday Soc., Trans. 21. pp. 36–41, Aug., 1925.)—The minimum overvoltage may be regarded [Abstract 2643 (1924)] as a measure of the free energy of the reaction $2H \rightarrow H_2$ when the total concentration of gas at the electrode is sufficient to overcome the forces at the electrode-electrolyte-gas interfaces so as to cause bubble formation. The presence of substances which alter the magnitude of the surface forces should hence influence the minimum overvoltage. Following Thiel and Breuning and MacInnes and Adler [Abstract 973 (1919)] the author finds that the addition of ethyl or methyl alcohol or of acetic acid to aqueous solutions (sulphuric acid, buffer solutions of pH varying from 3 to 11 and sodium hydroxide) lowers the surface tension and the overvoltage. Iso-amyl alcohol, which is sparingly soluble in water, whose surface tension it lowers considerably, first increases the overvoltage at a lead kathode, and then decreases it as more alcohol is added. The surface forces involved in bubble formation and also the size of the primary bubbles should be taken into consideration. H. B.

2797. *Variation of Viscosity and Electrolytic Conductivity with Temperature.* **M. Wien.** (Ann. d. Physik, 77. 5. pp. 560–586, 1925.)—Recently J. Malsch and the author described experiments [Abstract 657 (1925)] showing that the temperature coefficients of conductivity of different electrolytes were made up of two parts, the first due to the viscosity of the solvent and the second depending on the ion. Here, using the results of many old experiments, formulæ are derived giving definiteness to this point of view. If α is the temperature coefficient of the fluidity F_t at temperature t and β that of the conductivity λ_t, then for water and aqueous solutions: $\frac{1}{F_t}\frac{dF_t}{dt} = \alpha = \frac{1}{a + bt}$. By integration $F_t = F_{t'}[1 + q_{t'}(t - t')]^p$, where $p = 1/b$ and $q_{t'} = b/a_{t'}$, $a_{t'}$ being $= a + bt'$. These formulæ are shown to be in agreement with Hosking's measurements. The curve showing the variation of β with temperature is as a rule parallel to the corresponding curve for α, so that between 0° and 100° C. the relation $\beta = \alpha + \gamma$ holds. In this expression γ is with a single exception negative and for neutral salts has values from $-0{\cdot}2$ to $-0{\cdot}3$; for bases, $-0{\cdot}5$ to $-0{\cdot}7$; and for acids $-0{\cdot}8$ to $-1{\cdot}6$. It is a quantity characteristic of the ion. For most solutions γ is within the limits of experimental error independent of temperature and changes little or not at all with concentration. Only in the case of a few acids and acid salts are greater changes present, presumably connected with a change in the chemical constitution of the ions. Integrating $\beta = \frac{1}{\lambda_t}\frac{d\lambda_t}{dt} = \frac{1}{a + bt} + \gamma$, the expression for the conductivity λ is obtained, *viz.* $\lambda_t = \lambda_{t'}[1 + q_{t'}(t - t')]^p e^{\gamma(t - t')}$, where $[1 + q_{t'}(t - t')]^p$ gives the dependence of the fluidity of the solution on temperature and the last factor depends on the nature of the ion. The formulæ for β and λ are also confirmed by the results of experiments. G. A. S.

2798. *Conductivity of Electrolytes. II. The Mobility of the Hydrogen Ion at 25° C. III. The Correlation of Strong and Weak Electrolytes.* **C. W. Davies.** (J. Phys. Chem. 29. pp. 973–976 and 977–986, Aug., 1925.)—The importance of the equivalent conductivity at infinite dilution requires that it should be accurately known. From a consideration of the data of Kraus and Parker the value of 351·3 is derived for the mobility of the hydrogen ion at 25°, as compared with 347, the usually accepted value. At 25° C., HCl can be regarded as completely dissociated at concentration below 0·002 N, while that of HIO_3 is not complete at concentrations above 0·0001 N. At low concentrations the conductivity of an electrolyte is directly proportional to the square root of the concentration. If allowance is made for changes of mobility with dilution, the true degree of dissociation of a weak electrolyte can be calculated. [See Abstract 1778 (1925).] F. J. B.

2799. *Effect of Superposed Alternating Current on the Anodic Solution of Gold in Hydrochloric Acid.* **A. J. Allmand** and **V. S. Puri.** (Faraday Soc., Trans. 21. pp. 1–16, Aug., 1925.)—The solution of a silver-gold alloy in hydrochloric acid by electrolysis results in the formation of silver chloride, which adheres to the anode and interferes with the process of the gold solution. The superposition of alternating current on the direct prevents the adhesion of the chloride and allows a higher current density to be employed. The process was investigated. Current density-anode potential curves were taken for gold anodes in hydrochloric acid solutions, using direct current alone, and the same with alternating current superposed. The temperature, concentration of electrolyte, the ratio of strength of alternating current to that of direct current, and the frequency have all been varied and their effects on the curves were determined. F. J. B.

2800. *The Electrolysis of Ammoniacal Zinc Carbonate Solutions.* **T. P. Campbell.** (Am. Electrochem. Soc., Trans. 46. pp. 9–16; Disc., 16–21, 1924.)—The more important electrochemical properties of solutions of zinc in ammoniacal ammonium carbonate solvents are outlined, and the applications to hydrometallurgical practice are briefly considered. AUTHOR.

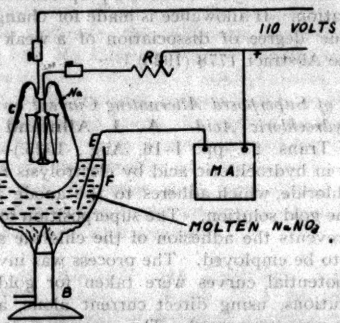
2801. *The Electrolysis of Hypochlorite Solutions.* **F. Foerster.** (Am. Electrochem. Soc., Trans. 46. pp. 23–50, 1924.)—A very careful survey of the subject is presented, and it is shown that it is simply the potential at which the anions of the hypohalogenites are acted upon by the current, as compared with the discharge potentials of the corresponding halogen ions, which determines the course of the electrolysis of alkali halogenides; and that all the details and apparent peculiarities in the phenomena attending these electrolytic processes may be investigated and satisfactorily explained with the aid of these potentials.

AUTHOR.

2802. *Amphoteric Character of Gelatine.* **P. K. Frölich.** (Am. Electrochem. Soc., Trans. 46. pp. 67–83; Disc., 83–86, 1924.)—Electrochemical reactions involving gelatine (glue) were examined from the standpoint of modern knowledge of the physical chemistry of proteins. The mechanism of copper deposition from acid electrolytes containing gelatine is discussed in detail and the effect of gelatine upon the kathodic polarisation and the resulting texture of the deposit is described. An explanation is suggested to account for the effect of gelatine as an addition agent in electrodeposition.

F. J. B.

2803. *Sodium by Electrolysis through Glass.* **R. C. Burt.** (Optical Soc. America, J. and Rev. Sci. Inst. 11. pp. 87–91, July, 1925.)—A common 40 or 50-watt metal-filament lamp is applied to a method of introducing sodium electrolytically through glass into the evacuated bulb by partly immersing in a bath of molten sodium nitrate at a temperature of 312° C., as shown in the figure.



The electrode E is connected to the positive wire of the 110-volt source through a milliammeter MA. The filament is lighted from this source through the resistance R, and the electrons emitted are carried to the glass wall opposite the molten salt by the field and neutralise sodium ions in the glass, which thus become atoms, volatilise and condense at the top of the bulb, where the glass is cooler. Sodium ions from the molten salt replace those of the glass and migrate through it. By modifying the connections to avoid local heating of the filament through ionisation currents, electrolysis currents as large as 0·3 amp. can be used and are found to follow Faraday's laws. The glass is impervious to potassium ions, and pyrex glass prevents the passage of even sodium ions. A very pure sodium spectrum can be obtained by this device, which is suitable for resonance radiation studies.

J. N. P.

2804. *Electrolytic Deposition of Cadmium and other Metals on Aluminium.* **C. H. Desch and (Mrs.) E. M. Vellan.** (Faraday Soc., Trans. 21. pp. 17–21; Disc., 21–22, Aug., 1925.)—The electrolytic deposition of cadmium and other metals on aluminium, to protect it against atmospheric corrosion, was studied. Pieces of aluminium sheet were carefully cleaned with potash to remove grease, scrubbed with pumice, whiting and water. The clean surface was then etched in an acid solution of ferrous chloride, cleaned with pumice and water or etched electrolytically in a solution of ferrous and calcium chloride, acidified with hydrochloric acid. Chemical cleaning was found to lead to blistering in the course of time, owing to the retention of the chemicals in the pores of the commercial aluminium.

Two alternative methods were employed : (*a*) Sand-blasting followed by immediate coppering in a hot solution of copper cyanide for 30–60 seconds, rapid washing in hot water, drying, sand-blasting and plating immediately without further treatment. (*b*) Sand-blasting followed by immediate immersion in the electrolytic ferrous chloride bath, making the aluminium the anode for 30 seconds and the kathode for 40–60 seconds, then drying and sand-blasting as in (*a*).

Cadmium was deposited from baths of cyanide, iodine, chloride, oxalate, sulphate and silicofluoride, and was obtained in good adherent deposits, but finally a bath consisting of 100 grammes of cadmium sulphate, dissolved in a small quantity of boiling water and cooled, is treated with ammonia until the precipitate is just redissolved. A freshly-made solution of 3 grammes of peptone is added and the solution made up to 1 litre. The free ammonia should be about 2·5 % by titration. In the absence of such excess the deposit is dark-coloured. The bath is acidified with sulphuric acid, boiled with powdered charcoal, allowed to digest in a warm place, filtered, brought back to its original alkalinity, and mixed with fresh peptone; anodes of cast cadmium, well amalgamated, were used. The deposits were all exposed to the atmosphere, and those which were subjected to the copper bath were on the whole more satisfactory. Nickel was deposited on aluminium with and without an intermediate deposit or cadmium. Experiments on the deposition of silver, iron and nickel on aluminium, were also made. F. J. B.

2805. *The Electrolysis of Nitrobenzene with the Mercury-dropping Kathode.* **M. Shikata.** (Faraday. Soc., Trans. 21. pp. 42–61; Disc., 61–62, Aug., 1925.)—Measurements are made of the current-voltage curves in the electrolytic reduction of nitrobenzene with the mercury-dropping kathode. With acid solutions the reduction potentials vary with the hydrogen-ion concentration in accordance with the Nernst equation. With neutral and alkaline solutions in presence of only traces of nitrobenzene a sudden increase of current occurs at definite potentials, which is attributed to surface activity or the property of nitrobenzene of concentrating in a Gibbs adsorption layer. Making use of the adsorption equation of Freundlich, the idea is put to a quantitative test and values of the exponent are calculated from the results. The presence of neutral salts makes the reduction potential of nitrobenzene more positive, which is attributed to their salting-out action, thereby concentrating the nitrobenzene in the surface layer. A maximum reduction current followed by a minimum is observed at certain potentials. The relation between the potential of maximum current and the hydrion concentration and " absolute zero " potential are studied experimentally and the part played by the adsorption of the oxygen groups of the nitrobenzene molecules on the mercury surface is discussed in accordance with Langmuir's orientation theory. The occurrence of a maximum reduction current is explained by desorption due to the applied polarisation current. A method of microanalysis of reducible organic compounds is proposed by measuring the effect exerted by traces of such compounds on the reduction potential of the saturation curves. Conversely, if a known quantity of nitrobenzene is added to a solution and electrolysed, the hydrion concentration can be calculated from the reduction potential. The great power of adsorption of nitrobenzene explains the ease of its reduction in spite of its slight solubility in water. [See Abstracts 2639, 2865 (1924).] J. N. P.

2806. *Brittleness of Zinc-plated Steel.* **H. Sutton.** (Faraday Soc., Trans. 21. pp. 91–98; Disc., 99–101, Aug., 1925.)—Experiments are described in which steel wires are electro-plated with zinc under varying bath conditions and then tested mechanically. Brittleness effects are detected by bending tests, though not revealed by tensile tests. The results obtained are in agreement with the conclusions arrived at by Johnson, Ledebur and others that the brittleness is ultimately due to occluded hydrogen. The brittleness is removed from wires coated with 0·0005 in. thickness of Zn by heating in boiling water or at 100° C. in air for 30 mins. The addition of small amounts of various colloids has no appreciable effect on the results. Tempering does not render steel immune from embrittling by subsequent plating, but the embrittlement is lessened with higher tempering temperatures. A. B. C. L.

2807. *The Introduction of Carbonaceous Matter in Electrodeposited Iron and Nickel.* **P. K. Frölich.** (Am. Electrochem. Soc., Trans. 46. pp. 87–103; Disc., 103–105, 1924.)—Iron is contaminated with organic matter when deposited kathodically from a complex ammonium oxalate electrolyte if this is prepared from ferrous ammonium sulphate, but not if ferrous chloride is used. Nickel deposited from a complex oxalate electrolyte always contains carbonaceous matter to an extent of from 1 to 2·5 %. Carbon monoxide and dioxide cause contamination of nickel deposits. Illuminating gas has only a negligible effect on the deposition of iron, while a large quantity of organic substance is introduced in nickel deposits. Acetylene is by far the most effective agent in giving rise to contamination of the deposits both of iron and nickel. The electrolytes employed are examined under the ultramicroscope, but the presence of colloids is not, in any instance, detected. Residues from the deposits are found to have a film structure and to consist of complex hydrocarbons. The metals which give rise to contamination are found to be especially the metals of the iron group, all of which are known to be catalysts in numerous gas reactions. The organic impurities are considered to be due probably to the products of gas reactions catalysed by the deposited metal. J. N. P.

2808. *Preparation of Metallic Tungsten and some of its Alloys.* **L. Kahlenberg** and **H. H. Kahlenberg.** (Am. Electrochem. Soc., Trans. 46. pp. 181–191; Disc., 191–195, 1924.)—Describes the preparation of pure tungsten, tungsten alloys and tungsten bronzes (*i.e.* metal or metal-compound powders, which, in suspension in amyl acetate, can be used as paints) by the solution of tungsten salts in alkali halides followed by electrolysis. To obtain a smooth deposit of ductile metallic tungsten a very low current density (0·015 amp./sq. cm.) is necessary. J. L. H.